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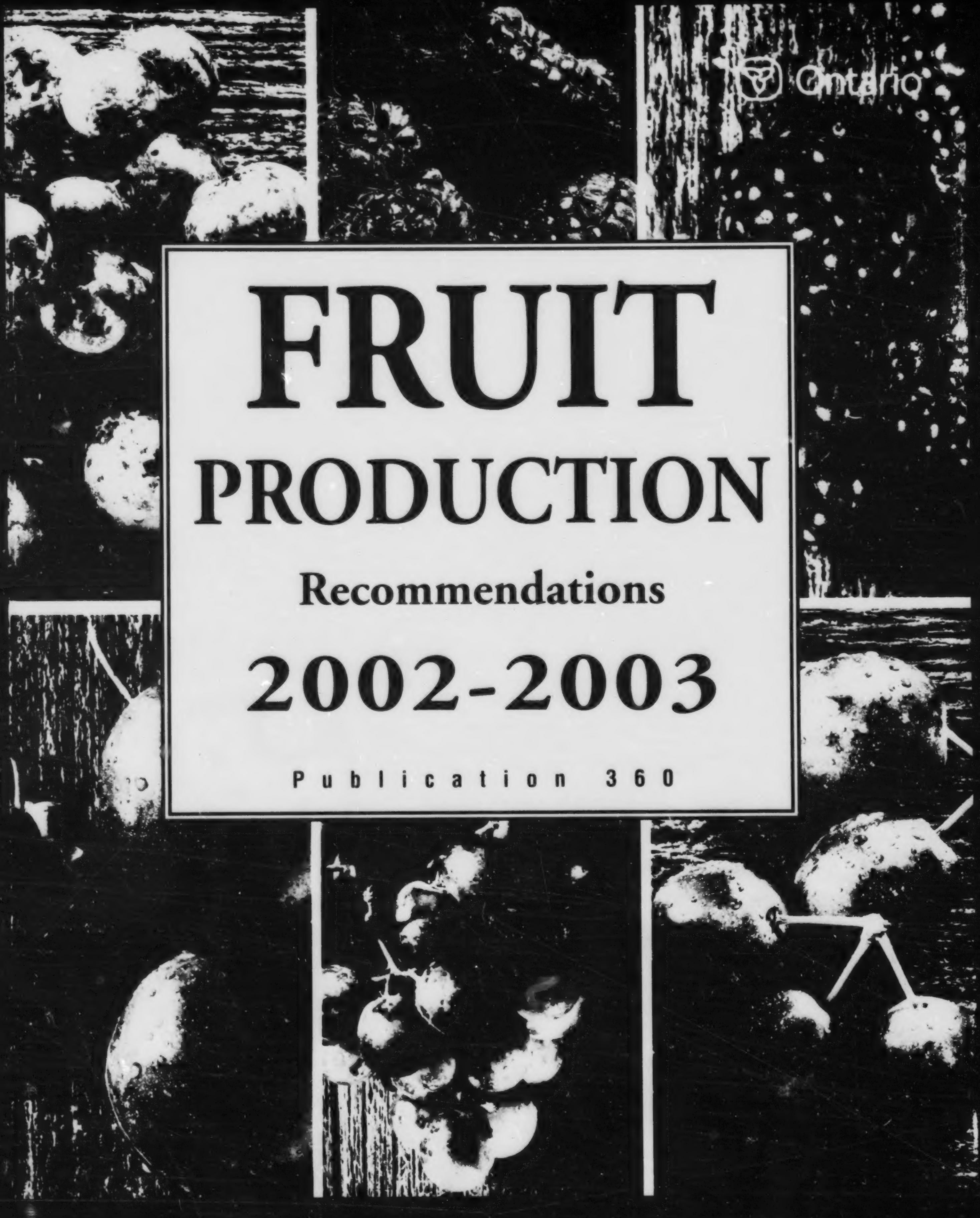

Ontario

FRUIT PRODUCTION

Recommendations

2002-2003

Publication 360

MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

Recycle old editions of this publication. Each year the appropriate working group of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the committee, at the time of printing, all of these pesticides were:

- federally registered
- reviewed by the Ontario Pesticides Advisory Committee (OPAC)
- classified by the Ministry of the Environment as of November 2001.

The information in this publication is general information only. By printing this publication, the Ministry of Agriculture, Food and Rural Affairs does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

The pesticide product label is a legal document. It is against the law to use the product in any other way.
You must also use all pesticides in accordance with the *Pesticides Act* and Regulation 914, administered by the Ontario Ministry of the Environment.

In this publication, most recommendations list several pesticides that can be used for each pest discussed. In general the least hazardous materials and those pesticides that pesticide applicators have used satisfactorily for years are listed first. More toxic pesticides and/or newer ones with less practical grower experience follow.

This publication lists a number of brand names of pesticides. This is for your convenience only. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

Consult each product label for specific information such as compatibility with other materials and the effect of environmental conditions. Weather and other factors influence the effectiveness of pesticides and the likelihood of crop injury.

Health Canada has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market as to which restrictions or limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada grants registration following an evaluation of scientific data to ensure that the product has merit and value; and the human health and environmental risks associated with its proposed use are acceptable.

1. **Full Registration**
   Pesticide registrations are normally granted for a period of five years, subject to renewal.
2. **Temporary Registration**
   Temporary registration may be granted for a period not to exceed one year, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Supplemental Labels

You MUST obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Temporary Registrations for Emergency Use**
- **Minor Use Label Expansion** (new label statements for crops that do not already appear on that product label)

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAFRA or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA web site at *www.hc-sc.gc.ca/pmra-arla* or call **1-800-267-6315.**

Regulation of Pesticides in Ontario

Classification of Pesticides into "Schedules"

The Ministry of the Environment classifies all pesticide products into one of six schedules, based on the potential hazards that product may have for human health and the environment. For up-to-date information on the regulatory status of any pesticide check the Ontario Pesticides Advisory Committee Web site at *www.opac.gov.on.ca* or call (416) 314-9230/fax (416) 314-9237.

Licensing and Certification Requirements for Pesticide Users

You must be a certified grower or licensed exterminator to buy and use Schedule 1, 2 and 5 pesticides.

Requirements for Growers and their Assistants

Growers must be certified through the **Grower Pesticide Safety Course** to buy and use Schedules 1, 2 or 5 pesticides on land they farm. There must be at least one certified grower for each farm operation.

All agricultural assistants must also receive formal pesticide safety training, recognized by the Ministry of the Environment, before they can use Schedule 2 or 5 pesticides under the supervision of a certified grower. This applies to all assistants — including family members, farm employees and seasonal workers.

For more information about training for growers and agricultural assistants check the Ontario Pesticide Education Program Web site at *www.ridgetownc.uoguelph.ca/opep* or call 1-800-652-8573.

Requirements for Commercial Applicators and their Assistants

If you plan to apply pesticides as a business, you must be a licensed exterminator. **This includes farmers who custom apply pesticides for other farmers and charge a fee for this service.** You must complete a home study course and certification exam, and send proof of certification to the Ministry of Environment to obtain your license.

Unlicensed assistants must be Technicians before they may handle Schedule 2 (with restrictions), 3, 4 and 6 products under indirect supervision of a licensed exterminator. Technicians may not handle Schedule 1 and 5 products. For more information about exterminators and technicians check the Ontario Pesticide Training and Certification Web site at *www.ridgetownc.uoguelph.ca/optc* or call 1-888-620-9999.

Cette publication est aussi disponible en français.

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Need technical or business information?

Contact the Agricultural Information Contact Centre at:

1-877-424-300 or ag.info@omafra.gov.on.ca

Looking for fruit production recommendations on the Internet?

www.gov.on.ca/omafra/english/crops/index.html

It's one-stop shopping for factsheets, articles and photos regarding the production and maintenance of Ontario's fruit crops.

Acknowledgements

The recommendations contained in this publication have been prepared in consultation with:

- Ontario Pest Management Research & Services Committee
- Ontario Pesticide Education Program
- Ontario Horticultural Research & Services Committee
- Ontario Soil Management Research & Services Committee
- Ontario Weed Committee

and personnel of:

- Crop Technology, OMAFRA
- University of Guelph
- Ontario Ministry of Envrionment
- Agriculture and Agri-Food Canada

Illustrations recreated, with permission, from the following publications:

- *Berry Production Guide for Commercial Growers, 2000-2001 Edition*
  Ministry of Agriculture, B.C., Lower Mainland Horticulture Improvement Association, 2000
- *Midwest Small Fruit Pest Management Handbook,*
  Ohio State University Extension, Columbus, OH, 1997
- *Midwest Tree Fruit Pest Management Handbook,*
  University of Kentucky Cooperative Extension Service, Lexington, KY, 1998

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1. Precautions with Pesticides

Pesticide Regulations

You must report all major spills, fires or thefts involving pesticides to the Ontario Ministry of the Environment at 1-800-268-6060. (*Regulation 914*, s. 29)

Pesticide Schedules in Ontario

The Ontario Ministry of the Environment reviews each pesticide product offered for sale in Ontario and classifies it into 1 of 6 groupings called Schedules.

Sch.	Who Can Use It	Pesticide Characteristics*
1	• licensed applicator • certified grower • only with approved permit	• **very toxic**, and/or • very persistent, and/or • highly mobile
5	• licensed applicator • certified grower • assistant agriculturist under supervision	• **very toxic**, and/or • very persistent, and/or • highly mobile • less toxic or less persistent alternative not available
2	• licensed applicator • certified grower • trainee or technician under supervision (some restrictions apply) • assistant agriculturist under supervision	• **toxic**, and/or • persistent, and/or • moderately mobile
3	• any person	• **moderately toxic**, and/or • moderately persistent, and/or • slightly mobile
4	• any person	• **low toxicity** • non-persistent • non-mobile • containers <1 kg <1 L
6	• any person	• **low toxicity** • non-persistent • non-mobile • containers >1 kg > I L

* Biological persistence and mobility in the environment, as expected under normal use conditions for Ontario.

For a list of pesticides in the publication, and their classification by schedule, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266.

Certification and Training Requirements

You must be a certified grower or a licensed applicator (exterminator) to buy and use Schedule 1, 2 and 5 pesticides.

Pesticide Certification for Ontario Farmers

Regulation 914 of the *Pesticides Act* makes it mandatory for farmers to be certified through the Grower Pesticide Safety Course to buy and use Schedules 1, 2 or 5 pesticides on land they farm.

There must be at least one certified grower for each farm operation. Under the *Pesticides Act*, you are a grower (farmer) if you:

- currently use farm land for agricultural or forestry production, and
- that farmland is classified as farmland property under Section 7 of the *Ontario Assessment Act*.

Training for Agricultural Assistants Using Schedule 2 or 5 Pesticides

As of January 2000, all assistants must have formal pesticide safety training that is recognized by the Ministry of the Environment, before they can handle or use Schedule 2 or 5 pesticides under the supervision of a certified grower.

- This applies to all assistants, including family members, farm employees and seasonal workers.
- Trained assistants do not have to write an exam.
- Trained assistants must be 16 years of age or older.

- There are 2 training options for assistants. Assistants can:
  - attend a grower pesticide safety course and not write the certification examination, or
  - attend an on-farm training session presented by a qualified trained assistant instructor.

For more information and a listing of grower pesticide safety courses and exam-only session dates and locations, check the Ontario Pesticide Education Program Web site at www.ridgetownc.uoguelph.ca/opep/.

To register for a grower pesticide safety course or GPSC exam-only session (if you are renewing your certificate) anywhere in Ontario, or for information about trained assistants please:

- call: 1-800-652-8573
- fax: 1-519-674-1589
- e-mail: opep@ridgetownc.uoguelph.ca

Certification and Licensing for Commercial Applicators

You must be a licensed exterminator if you plan to apply pesticides as a business. This includes farmers who custom-apply pesticides for other farmers and charge a fee for this service. Licensed exterminators who are self-employed must hold an operator licence as well as the appropriate exterminator licence. Exterminator licenses are valid for 5 years.

To become a licensed exterminator, you must:

- complete a home study course and certification exam through Ridgetown College, University of Guelph, **and**

- send proof of certification (letter of successful completion of the exam(s)) and a fee to the Ministry of the Environment to obtain your exterminator licence. (See Appendix C, *Ontario Ministry of the Environment Pesticides Control Offices*, on page 285.)

Training for Technicians and Licensed Exterminators

Technicians can mix, load or apply all Schedule 3, 4 and 6 pesticides and most Schedule 2 pesticides (some restrictions apply), under the indirect supervision of a licensed exterminator. Technicians cannot mix, load or apply Schedule 1 or 5 pesticides. Technician cards are valid for 2 years. To become a technician, you must:

- complete an MOE-approved academic course and exam, **and**

- complete practical training with a licensed exterminator.

For more information about certification and licensing requirements for licensed exterminators and training for technicians, contact Ontario Pesticide Training & Certification:

- call: 1-888-620-9999
- fax: 519-674-1585
- Web site: www.ridgetownc.uoguelph.ca/optc

General Precautions

Always read the label:

- before you buy a pesticide!
- before you begin to use a pesticide!
- before you store a pesticide or dispose of it!

Learn about the health hazards and toxic properties of the pesticide you are using. Consult the product label, Material Safety Data Sheets (MSDS), or manufacturer for this information. Check the company Web sites for MSDS information.

Protect Yourself When You Use Pesticides

- **Make sure someone knows** where you are working, what pesticides you are handling and how long you expect the job to take.

- **Post emergency numbers**, including the Poison Information Centre and Spills Action Centre, near all telephones.

- **Keep a list of the names and the Pest Control Products (PCP) Act Registration Numbers of all pesticides you handle.** Keep a file of the pesticide label booklets for all products you use. Make sure your co-workers and family members know where this list or file is in case of an accident.

- **Have plenty of clean water, soap and paper towels and an extra set of gloves and coveralls nearby at all times** in case a pesticide contaminates your clothing or skin.

- **Wear the correct protective clothing and equipment, and be sure all items are clean and in good repair, before you put them on.**

- **Never smoke, chew tobacco, eat or drink when you handle pesticides.** Never carry tobacco or food in your clothes and never leave tobacco, food or beverages in areas where you handle or store pesticides.

- **Change your clothes and wash your hands and face before you eat, drink or smoke.**

- **Wash your hands *before* you use the toilet, as well as after.** The skin in your groin area absorbs pesticides very easily.

- **Pregnant women should not handle or use pesticides.**

Protect Other People, Livestock, Pets, Water and Sensitive Crops

- Buy and store only what you need.
- Prevent drift.
- Keep pesticides out of water.
- Clean up spills quickly and safely.
- Dispose of containers and waste pesticide safely.

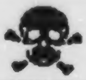
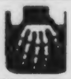
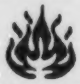
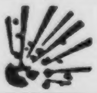
Read and Follow Pesticide Label Information

Know the Hazard Symbols and Words

Learn these symbols and words — they could save your life!

Check the label for special warnings about eye hazards and skin hazards. The front panel of the pesticide label may also contain warnings that tell you the product is corrosive to eyes, or is a skin or eye irritant.

Four important symbols and words show the potential hazards of pesticides.

Hazard Symbol	Signal Word
	**Poison**
	**Corrosive**
	**Flammable**
	**Explosive**

The hazard symbol always appears inside one of the shapes shown below. These shapes and their warning words tell you the degree of hazard of the pesticide. **The greater the number of sides to the shape, the more hazardous the product.**

	Warning Symbol	Signal Word
Triangular shape means low hazard (3 sides)	▽	**Caution**
Diamond shape means moderate hazard (4 sides)	◇	**Warning**
Octagonal shape means high hazard (8 sides)	⯃	**Danger**

Re-Entry Periods

Re-entry period is the minimum amount of time that must pass between the time the pesticide was applied and the time that workers can go into the crop area without wearing personal protective equipment. If workers enter fields without wearing protective equipment too soon after pesticides have been applied they may experience poisoning. Such poisoning can result from handling treated plants or from inhaling pesticide vapours.

Table 1–1, *Re-Entry Periods for Pesticides Used on Fruit Crops,* on page 4 shows a specific minimum interval that you must observe between applying the pesticide and working in the treated crop without protective equipment.

- Some pesticides, like parathion, have labels that carry a warning about working in treated crops. Follow the label recommendations.

- Do not enter treated areas without protective equipment until the suggested time has passed.

- Use this table as a guide, but refer to the product label for specific information.

- If no re-entry period is stated on the label, assume that the spray solution must be dry before re-entry can occur.

Days to Harvest (Preharvest) Intervals, Pregrazing and Feeding Intervals

These intervals state the minimum amount of time that must pass between the last pesticide application and the harvesting of the crop, or the grazing or cutting of the crop for livestock feed. If you harvest a crop before the preharvest interval has passed, there may be pesticide residues in excess of the Maximum Residue Limits (MRL) set by Health Canada. When crops with persistent residues are fed to livestock, the pesticides may poison the animal or may contaminate the milk or meat.

To avoid exceeding the Maximum Residue Limits, always follow the label.

The days to harvest intervals for products used in this publication are listed in Table 13–3, *Number of Days from Last Spray to Harvest*, on page 276.

For example, when controlling insects do not apply an insecticide later than the recommended number of days from harvest. For instance, Matador 120 EC 42–83 mL (3 days) indicates not to use the Matador spray later than 3 days before the beginning of harvest, and that no more than 83 mL of an emulsifiable concentrate formulation containing 120 g/L Matador should be used for 1 ha of crop in an application.

Crop Rotation Statements

Some pesticides can persist in treated soil and crops sensitive to that pesticide may be injured if they are planted too soon after the treated crop is harvested.

TABLE 1–1. Re-Entry Periods for Pesticides Used on Fruit Crops

Minimum interval before re-entry	Product Trade Name	Special comments
4 hours	ELEVATE 50 WDG	
	SUCCESS 480 SC	Depending on activities, consult label.
12 hours	ALIETTE WDG	
	NUSTAR	
	RIDOMIL GOLD MZ	
	ROVRAL	
24 hours	ADMIRE	
	AGRI-MEK 1.9EC	
	LANNATE	
	LORSBAN 50 W	
	MATADOR120 EC	
	PENNCOZEB 75 DF	
	PIRIMOR 50 DF	
	PYRAMITE	
	VYDATE	
48 hours	APM 50 W INSTAPAK	Longer re-entry required for some tasks. See label.
	BRAVO 500	
	DIKAR	See label for special precautions.
	FURADAN 480 F	
	GAVEL 75 DF	
	GUTHION SOLUPAK	Longer re-entry required for some tasks. See label.
	MAESTRO 80 DF	48–72 hrs. See label.
	SNIPER	Longer re-entry required for some tasks. See label.
	VANGARD 75 WG	48–72 hrs. See label.
72 hours	MAESTRO 80 DF	48–72 hrs. See label.
	RONILAN	Less with protective clothing.
	VANGARD 75 WG	48–72 hrs. See label.
7 days	SOVRAN	Less for certain tasks with protection.
14 days	PARATHION 15 W	Wear protective clothing between 2–14 days. See label.
Other	MITAC W	See label precautions.

Some labels state a minimum waiting time that must pass before it is safe to plant sensitive crops.

Total Number of Applications

Some product labels state the total number of applications of that pesticide that can be made during a growing season. These limits prevent food residues, crop damage, soil residues or pest resistance.

Buffer Zones

Buffer zones are areas left untreated to protect an adjacent area, for example a pond, a stream, a sensitive crop, a non-target crop, wetland or woodland etc.

Human Health

Risk = Toxicity X Exposure

Risks of Pesticide Use

Each time you handle a pesticide, you are at some risk. The amount of risk depends on 2 things: the toxicity of that pesticide and your exposure to it.

Toxicity is a measure of how harmful or poisonous the pesticide is. There are 2 types of toxicity:

- **Acute toxicity** is the toxic response that results from a **single exposure** to the pesticide. The symbols and words on the front panel of a pesticide label give you information about the acute toxicity.

  Lethal Dose 50% (LD50) is a measure of acute toxicity. It is the dose (mg of product/kg of body weight) that will kill 50% of the test animals within a stated period of time (24 hr, 7 days).

  Examples of products listed in this publication with a high acute toxicity are listed in Table 1–2, *Relative Acute Toxicity of Pesticides*.

TABLE 1–2. Relative Acute Toxicity of Pesticides

Use this table as a guide, but refer to the product label for specific information. Information about specific hazards such as corrosiveness, and skin or eye irritations are not included in this table but can be found on the product label.

Danger Symbol High Acute Toxicity	Warning Symbol Moderate Acute Toxicity	Caution Symbol Lower Acute Toxicity	
CARZOL SP	AGRI-MEK 1.9 EC	ADMIRE	MAESTRO 80 DF
DECIS 5 EC	BUSAN 1020	ALIETTE WDG	MALATHION 25W
DIAZINON 500E	COPPER 53W	APOLLO SC	MANZATE 200 WP
DIAZINON 50W	CYGON 480	BENLATE T-N-G	MANZATE 200 DF
DZN 600 EW	CYMBUSH 250 EC	BIOPROTEC CAF	MERTECT SC
ENDOSULFAN 50W	MITAC W	BOTRAN 75W	MICROSCOPIC SULPHUR 92 WP
FURADAN 480F	PYRAMITE	BRAVO 500	NOVA 40 W
GUTHION 240 SC	SEVIN XLR PLUS	CAPTAN 80 WDG	NUSTAR
GUTHION SOLUPAK	VAPAM	CONFIRM 240F	PENNOCOZEB 75 DF
IMIDAN 50 WP		DIKAR	POLYRAM DF
LANNATE		DIPEL 2X DF	RIDOMIL COPPER 70WP
LORSBAN 50 W		DITHANE DG	RIDOMIL GOLD 480 EC
MATADOR 120 EC		DITHANE M45	RIDOMIL GOLD MZ 68 WP
PARATHION 15 W		ELEVATE 50 WDG	RIPCORD 400 EC
PIRIMOR 50 DF		EQUAL 65 WP	RONILAN EG
POUNCE		FERBAM 76 WDG	ROVRAL
SNIPER 50 W CLEANPAK		FOLPAN 50 W	SENATOR 70 WP
TELONE C-17		FORAY 48BA	SOVRAN
THIODAN 4 EC		FUNGINEX 190EC	STREPTOMYCIN 17
THIODAN 50 WP		GAVEL 75 DF	SUCCESS 480SC
THIONEX 50 WP		KELTHANE 50 W	TOPAS 250 EC
VYDATE L		KUMULUS DF	VANGARD 75 WG
ZOLONE FLO		LIME SULPHUR	ZINEB 80 W

- **Chronic toxicity** is the toxic response that results from **repeated exposures** to small doses of a pesticide over a longer period of time. These toxic effects may not appear for months or years after exposure to the pesticide. The symbols on the label do **NOT** give information about the chronic toxicity of the product. Use protective clothing and equipment to help reduce exposure and the risk of chronic effects.

Cholinesterase Blood Tests

Organophosphorus and *carbamate* pesticides can affect your nervous system. These pesticides can change your serum and red blood cell levels of an enzyme called acetyl cholinesterase. Your body uses this enzyme to transmit messages through your nervous system. If your cholinesterase levels fall, you can experience symptoms including trembling, twitching, blurred vision, difficulty breathing and heart difficulties.

If you use any of the groups of pesticides listed below on a regular basis, you should have regular cholinesterase blood tests. (See Table 1–3, *Pesticides that Affect Cholinesterase Levels in Blood.*) Your family doctor can arrange these tests, which are covered by OHIP. **Have your first test *before* you begin to handle these pesticides.** That shows the baseline (normal) cholinesterase level for your body. During the spray season, if you are spraying organophosphorus or carbamate insecticides regularly for several weeks, have a cholinesterase blood test every **7–10 days.** If your cholinesterase level drops to below one-half of your baseline level, then you are showing signs of pesticide poisoning and **you must remove yourself from exposure** to these pesticides until your cholinesterase level returns to normal.

Exposure is a measure of the contact you have with a pesticide. You can be exposed to a pesticide in 3 ways.

- **Dermal exposure** occurs through your skin or eyes. The amount and rate of pesticide that may be absorbed depends on several things, including:
  - your skin condition. If your skin is moist, or if you have rashes, broken skin or scratches, a pesticide will be absorbed more easily.
  - the part of your body that is exposed. Your eyes, genital area, scalp and ear canals absorb pesticides at a higher rate than your hands or arms. Your eyes absorb pesticides at a rate of 100%.

TABLE 1–3. Pesticides That Affect Cholinesterase Levels in Blood

PRODUCT NAME	Active ingredient
APM 50 W INSTAPAK	azinphos-methyl
CARZOL SP	formetanate hydrochloride
CYGON 480	dimethoate
DIAZINON 50 W	diazinon
DIAZINON 500 E	diazinon
DZN 600 EW	diazinon
FURADAN 480 F	carbofuran
GUTHION 240 EC	azinphos-methyl
GUTHION SOLUPAK	azinphos-methyl
IMIDAN 50 W	phosmet
LANNATE	methomyl
LORSBAN 50 W	chlorpyrifos
MALATHION 25 W	malathion
PARATHION 15 W	parathion
PIRIMOR 50 WP	pirimicarb
SEVIN XLR PLUS	carbaryl
SNIPER 240 E	azinphos-methyl
SNIPER 50 W CLEANPAK	azinphos-methyl
VYDATE	oxamyl
ZOLONE FLO	phosalone

- **Respiratory exposure (inhalation)** occurs when you inhale small spray particles, dust, gases or vapours.

- **Oral exposure** occurs when a pesticide enters your mouth or you swallow a pesticide.

First Aid

1. Always protect yourself from injury first. Don't become another victim. Always put on protective clothing and equipment before you enter a contaminated area or handle a contaminated victim.

2. Check to see if the victim is breathing.

   If the victim is not breathing:

   - Straighten the victim's airway and check for breaths.
   - If the victim does not begin to breathe, administer artificial respiration until the victim begins to breathe on his/her own.

- Do not contaminate yourself, especially if the victim has pesticide or vomit around his face or mouth. Use a face shield airway with a one way valve. Do not breathe the exhaled air from the victim.
- Perform CPR if the victims pulse disappears. Only perform CPR if you are trained to do so.

If the victim is breathing, but unconscious:

- Place the victim in the recovery position (on the side with the head turned slightly to one side). If the victim vomits, try to keep the airway clear.

3. Stop the exposure to the pesticide. Move the victim away from the contaminated area. Remove all contaminated clothing. Use soap and water to wash any skin exposed to the pesticide.

4. Check the Four Basic Facts:

   - **Identify the pesticide**. Look for the label, container or leftover pesticide.
   - **Quantity.** How much product was the victim exposed to?
   - **Route of entry.** How did the pesticide enter the body? Did it enter through the mouth, skin/eyes or lungs?
   - **Time period.** How much time has passed since the victim was exposed to the pesticide, and how long was the exposure? Were the symptoms immediate or did the poisoning occur as a result of using the pesticide over a longer period of time?

Don't waste time. If you can't answer these questions quickly, be ready to tell emergency personnel whatever you can.

5. Call an ambulance or the Poison Information Centre.

6. Start the first aid treatment appropriate for the route of entry.

7. Make sure the patient gets medical attention. First aid is not a substitute for professional medical help.

Emergency and First-Aid Procedures for Pesticide Poisoning (See inside back cover)

If symptoms of illness occur during or shortly after handling a pesticide, go to a hospital. Take the pesticide label, MSDS sheet, or pesticide container with you. Do not transport the container in the passenger compartment of the vehicle.

Protective Clothing and Equipment

Choose and Wear the Appropriate Protective Clothing and Equipment

Make sure your protective clothing and equipment:

- is what you need for the job
- fits properly, and
- is clean and in good repair and working condition.

The protective clothing and equipment you need to wear depends on:

- **the pesticide you are using.** READ THE PRECAUTIONS SECTION OF THE LABEL TO KNOW WHAT TO WEAR.

- **the job you are doing.** For example, you need more protection when you handle concentrated pesticide, or when you mix and load your sprayer.

- **the type of application.** Enclosed space or air blast sprayer applications made with open tractors require more equipment.

Each person who is working with pesticides needs **their own** set of protective clothing and equipment. Consult the technical expert at your safety supply company to make sure that you purchase the appropriate equipment and that it fits the user.

For ALL pesticides, always wear:

- A water-repellent hat such as a hard hat or waterproof rain hat. Do not wear hats made from cloth.
  - Baseball-style caps absorb pesticides and are not safe.

- Long pants and a shirt with long sleeves, or a coverall.
  - Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven.
  - Choose water-resistant coveralls. Cotton, denim and cotton-polyester fabrics can cling if wet and transfer pesticides to your skin. If you spill pesticide on your clothing, remove the clothing immediately.

- Chemical resistant gloves (unlined).
  - Use neoprene or nitrile gloves, unless the label states otherwise. Do not wear rubber gloves as many pesticides can break down the rubber material. Wear your gloves under your sleeves with the top cuffed.

- Chemical resistant boots (unlined).

Read the label. It describes what extra protective clothing and equipment to wear. For some pesticides you may also need to wear:

- goggles
  - Use safety goggles. Regular eyeglasses don't provide complete protection. Never wear contact lenses when you handle pesticides.

- face shield

- chemical resistant apron

- respirator
  - A respirator is a unit that covers your mouth and nose to prevent spray droplets, small particles, and vapours from getting into your lungs. **A dust mask is not a substitute for a pesticide respirator.** When you buy a respirator or replacement cartridges, make sure the cartridges and prefilters protect you against organic vapours. For more information about respirators, refer to the *Grower Pesticide Safety Course Manual*, Ridgetown College, University of Guelph.

You may need more protection, such as **Canister Gas Masks or Self-Contained Breathing Apparatus (SCBA)** when you apply:

- any pesticide in an enclosed area, or
- fumigants, gases, vapours or smokes.

ALWAYS wear a respirator when you work with fumigants, gases or vapours, or when you apply any pesticide in an enclosed area.

Use **Organic Vapour Tractor Cab Cartridges.** If you use a tractor with a cab when you spray, the tractor cab cartridges work the same as an air-purifying respirator. These cartridges and prefilters **must** be replaced and maintained regularly to provide continued protection.

When you use **air- blast sprayers and mist blowers and tractors without cabs**:

- wear the appropriate respirator, as well as a waterproof suit, head covering, chemical resistant gloves, boots, and eye protection. Once you complete the spray application, clean your protective equipment and the tractor. Do not operate the tractor without wearing protective clothing and equipment, unless it has been decontaminated.

Safety Supply Companies

Consult the safety supply company(s) of your choice for help in selecting your protective clothing and equipment. (See Table 1–4, *Safety Supply Companies in Ontario Providing Protective Clothing & Equipment,* on page 9.)

Care of Protective Clothing and Equipment

- After you complete the spray operation, clean all protective clothing and equipment.

- Never let children, pets or livestock come in contact with contaminated clothing or equipment. Make sure they do not come into contact with the puddles of water that result from cleaning your equipment.

- Wash your gloves with soap and water, then *leave them on* to remove your other protective clothing and equipment.

- Always remove protective clothing and equipment outdoors. If a granular pesticide was used, shake the clothing outdoors in a safe place, emptying pockets and cuffs.

TABLE 1–4. Safety Supply Companies in Ontario Providing Protective Clothing & Equipment

3-M Canada Inc.	Occupational Health and Environmental Safety, Box 5757 London, ON N6A 4T1	(519) 452-6165 1-800-364-3577 Fax: (519) 452-4660
Acklands Grainger	90 W. Beaver Creek Rd. Richmond Hill, ON L4B 1E7	(905) 731-5516 1-800-668-8989 Fax: (905) 731-2798
Aearo Canada	7115 Tomken Rd. Mississauga, ON L5S 1X7	(905) 795-0700 1-800-387-4304 Fax: (905) 564-5250
Dutch Industries Protect-Air Cab Filter	Huron Tractor, Box 1300 Exeter, ON N0M 1S3	(519) 235-1115 Fax: (519) 255-1939
HAMISCO	3392 Wonderland Rd. London, ON N6L 1A8	(519) 652-9800 1-800-668-9800 Fax:(519) 652-9661
Kappler Canada	Box 1687 20 Ryan Place Brantford, ON N3T 5V7	(519) 752-4369 1-800-387-9326 Fax: (519)752-2161
Levitt-Safety (Eastern) Limited	2872 Bristol Circle Oakville, ON L6H 5T5	(905) 829-3299 1-800-668-6153 Fax: (905) 829-2919
MSA Canada Inc.	148 Norfinch Dr. North York, ON M3N 1X8	(416) 667-9400 1-800-267-0672 Fax: (416) 663-5908
Mitt & Robe Co.	751 Norfolk St. N. Simcoe, ON N3Y 3R6	(519) 428-4050 1-877-893-6565 Fax: (519) 428-5142
Plant Products Co. Ltd.	314 Orenda Road Brampton, ON L6T 1G1	(905) 793-7000 1-800-387-2449 Fax: (905) 793-9632
Safety Express	4060B Sladeview Cres., Unit 2 Mississauga, ON L5L 5Y5	(905) 608-0111 1-800-465-3898 Fax: (905) 608-0091
The Saint George Company (Suppliers of Kasco Helmets)	P.O. Box 430 20 Consolidated Drive Paris, ON N3L 3T5	(519) 442-2046 1-800-461-4299 Fax: (519) 442-7191

- Throw out clothing contaminated by spills of highly toxic or concentrated pesticide. Place clothing in a plastic bag and take it to a landfill site.

- **Coveralls and other spray clothing must be washed separately from other clothes.** Wash after each use. Place them in a plastic bag and keep them separate.

- With your hands still protected by gloves, wash protective equipment. It is best to wash equipment outdoors. If you do not have an outside clean-up area, keep certain buckets just for equipment clean up. Mark them and keep them in a special place. Wash the inside and outside of your goggles, hat, boots, and any water-repellent clothing in warm soapy water, rinse well and let them air-dry.

- Remove the cartridges and prefilters from the respirator.

- Discard cartridges, canisters and filter pads when breathing becomes difficult, when you notice a pesticide taste or odour, or at the interval set by the manufacturer.

    - Note the date the cartridge is first used.
    - Remove cartridges and filter pads from the face piece and store in clean, sealed plastic bags.
    - Wash the face piece in warm soapy water, rinse thoroughly, and dry in a well-ventilated area. Air-drying prevents damage to the inlet and outlet valves.
    - Never use alcohol or other solvents for cleaning, as they damage the rubber and plastic.

- Next wash the outside of your gloves with soapy water and remove them.

- After removing boots and gloves, wash them inside and out with detergent and water, rinse thoroughly, and dry in a well-ventilated area.

- Place all dry articles in a clean storage area until next use.

How to Wash Your Spraying Clothes

Never mix spray clothing with household laundry. All clothing used for spraying must be stored and washed separately from other clothing. Wash after each use. Remember to use chemical resistant gloves to handle pesticide-contaminated clothing.

- Presoak clothing before washing. Use 1 of 3 methods:
  - hose-off garments outdoors
  - soak in separate tub or pail
  - use the prewash cycle in automatic washer

- Place clothing directly into the washing machine. Wash only a few garments at a time. Do not wash with other family clothes.

- Use hot water, the highest water level, and the longest cycle, with heavy duty detergent. Wash as you would for heavily soiled clothing.

- Wash clothing again.

- After washing, hang outside (preferably in bright sunlight) until completely dry. Do not use the clothes dryer.

- Clean the washing machine. Run the washing machine through one complete cycle using only detergent and hot water. (No clothing.)

Personal Hygiene

- **When you are finished for the day, take a bath or shower as soon as possible.** The longer a pesticide remains on your skin, the greater the risk it will be absorbed into your body.

- Always shower before eating, drinking, or smoking. Wash your hair and under your fingernails. Shower with lots of soap and water.

- Always change into clean clothes.

- Wear clean work clothes every day. A small spill on the previous day's clothes may seem unimportant, but wearing the same clothing again without washing it prolongs the exposure and increases your risk.

Protect the Environment

Protect Water Sources

- You must use an anti-backflow device to prevent back siphoning when drawing water from wells, ponds, streams or other sources.

- Mix pesticide and load the sprayer **at least 50 m away** from any water supply, including wells, ponds or streams.

- Use buffer zones (untreated areas) when you apply pesticides to avoid contaminating surface water, wells, ponds and/or streams. Check the product label for specific buffer zone distances.

Reduce and Manage Pesticide Spray Drift

Spray only when winds are light to moderate. If you notice drift is occurring because of the wind, **stop spraying** until the wind subsides. Do not apply pesticides if the wind is blowing towards susceptible crops or environmentally sensitive areas such as watercourses.

- Read the product label for information regarding buffer zones, water volumes and recommended nozzles.

- Use buffer zones around all watercourses, wells and neighbouring fields that contain sensitive crops. If the label does not state a specific buffer zone distance, leave an untreated area of natural vegetation.

- Select the recommended sprayer application rate (L/ha).

- Select the correct nozzle. Where practical, use air induction/venturi nozzles. These nozzles significantly reduce drift when compared to conventional nozzles.

- Select the correct nozzle-to-target distance.

- Use spray-plume protection where practical or available (hoods, shrouds, screens and air curtains).

- Use drift-reducing adjuvants in the spray tank as directed by the label.

- Utilize wick weeders, instead of spraying, when possible.

For more information about spray drift consult OMAFRA Factsheet, *Reducing Pesticide Drift and Crop Damage*, Order No. 00-103, OMAFRA/ Agriculture and Agri-Food Canada booklet *Best Management Practices Pesticide Storage, Handling and Application* and the Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift* and *Spray Drift Reduction through Air Induction*.

Prevent Bee Poisoning

See *Bee Poisoning* on page 58, for recommendations on prevention of bee poisoning. See Table 6–1, *Relative Toxicity Of Pesticides To Honeybees*, on page 59.

Read each pesticide label for specific precautions regarding bees.

Disposal of Pesticides and Empty Pesticide Containers

Triple or Jet Rinse Your Empty Pesticide Containers

Unrinsed pesticide containers are not really empty. They may still hold about 1% of the original amount of pesticide. Although this figure sounds low, it is still a hazard to humans, animals, and the environment. To reduce the hazard, rinse each container 3 times as the spray tank is filling. Use either the manual triple-rinse technique, or a specially designed device for rinsing containers. Paper or cardboard containers are often strong enough to be rinsed. If it is possible, rinse these containers as well as plastic ones.

To Triple Rinse

1. Fill the empty container at least 10% full with the diluting material (usually water).

2. Cap, then shake or roll the container so that the inside surfaces of the container are well rinsed.

3. Pour rinsings into the spray tank.

4. Repeat steps 1–3 twice more.

Remember to check the container after you have finished rinsing. Make sure no pesticide has been left behind as a cake or paste on the bottom of the container.

Rinsing Devices

Rinsing devices use pressurized water to clean the container. They are just as effective as triple rinsing but take less time. Follow the manufacturers instructions.

How to Dispose of Empty, Triple-Rinsed Containers

Never reuse empty pesticide containers. They may be handy, but there is still some risk, even if the containers are triple rinsed. Never give empty, rinsed containers to anyone, especially not children. Dispose of them promptly.

Regulation 914 of the *Pesticides Act* regulates how pesticide containers are to be disposed of in Ontario.

For Metal, Plastic, or Glass Containers

Dispose of an empty metal, plastic, or glass container that has been used to hold a Schedule 1, 2, 3*, 5 or 6* (*non-domestic) pesticide by triple rinsing or jet rinsing using clean water, or another appropriate solvent

AND either

- taking it for recycling to a pesticide container depot

OR

- taking it to a licensed waste disposal site.
  (Reg. 914, s. 27)

Once properly rinsed, puncture the containers so they cannot be reused and to make sure the rinse water is totally out of the container.

It is often more convenient to store empty, rinsed containers until you have collected enough to make a trip to the recycling pesticide container depot or the waste disposal site. If you store containers, keep them in a dry safe place, such as the storage area, until you can dispose of them properly.

Recycling

The Ontario Pesticide Container Recycling Program is available to growers and commercial applicators. Through this program, **clean, triple rinsed, plastic/metal pesticide containers** (up to 23 L in size for plastic and 20 L in size for metal) can be returned to pesticide container depots located throughout the province. To locate the pesticide container recycling depot closest to you, call the Ontario Pesticide Education Program at 1-800-652-8573.

Future Farm Supply in Aylmer has a recycling pesticide container depot to collect empty metal drums that contained sucker oil and fumigants used in tobacco and fruit production.

For Paper and Cardboard Containers

Dispose of a paper or cardboard container that has been used to hold a Schedule 1, 2, 3*, 5 or 6* (*non-domestic) pesticide by triple rinsing or jet rinsing (if possible) using clean water

AND either

- burning, (if allowed by municipal by-laws) in circumstances that persons and animals are kept out of any smoke produced and any smoke is directed away from buildings, highways, roads, or outdoor areas frequented by the public

OR

- taking it to a licensed waste disposal site. (Reg. 914, s. 27)

Paper or cardboard containers are often rigid enough to withstand rinsing. If possible, triple rinse these containers as you fill the tank. Then burn the containers in an isolated area on your farm.

Be very careful around the smoke. It may contain toxic fumes from the burning pesticide. Be certain there is no chance that a person or animal may breathe in this smoke. Make sure the smoke does not drift toward buildings, roads, or any public outdoor areas.

These containers can also be taken to a local waste disposal site in the same way as metal, plastic, or glass containers. If you can't dispose of them immediately, make sure containers are kept in a secure place such as the pesticide storage area.

Unwanted Pesticides

If you have pesticides you do not need or cannot use, be sure to dispose of them safely.

- Contact the supplier. It is sometimes possible to return unused pesticide if it is still in its original container.

- If you cannot find any way to use the product as shown on the label, then the Ministry of the Environment requires that waste be disposed of by licensed waste haulers to a licensed waste disposal site. Look in the Yellow Pages under Liquid Waste Removal.

- Watch your local paper for Municipal Waste Collection Days or contact your municipality. If your municipality has no waste collection days, encourage them to sponsor such an event. On these days, you can turn over surplus pesticide concentrates (maximum 25 L) for disposal.

- Consult with the regional Ministry of the Environment Office for more information. [See Appendix C, *Ontario Ministry of the Environment Pesticides Control Offices*, on page 285.] The ministry has an agreement with Safety-Kleen to dispose of unwanted pesticides on a user-paid basis. Contact Safety-Kleen in London, Ontario at (519) 451-6630 for disposal of unwanted or contaminated pesticides.

Surplus Spray Mix

The best way to dispose of any excess spray mix is to find other fields that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that crop.

If you can't find another field to spray, then dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. This diluted solution can be safely applied to the treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest, or surplus spray mix disposal.

NEVER respray the treated field with undiluted spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Soluble Packaging Options

Choose soluble packages that dissolve in the spray tank to reduce container disposal. Water-soluble packaging is used for dry flowable and wettable powder formulations of pesticides and is available under names such as Clean Pak, Solupak, and Toss-N-Go. In most cases, the water-soluble packaging material is PVA (polyvinyl alcohol). This material dissolves completely when added to the water in the sprayer tank according to instructions.

Read all labels and instructions carefully. For more details contact your vendor. For more information on using products in soluble packaging, see Chapter 2, *Soluble Packaging Options* on page 16.

Storing Pesticides

Ontario's *Pesticides Act* and Regulation 914 give storage requirements for storage facilities. The storage requirements you must follow depend on which Schedules of pesticides you store.

See also OMAFRA Factsheet, *Pesticide Handling Facilities*, Order No. 94-037.

***Pesticides Act* Storage Requirements**

	Sch. 3, 4 & 6	Sch. 2	Sch. 1 & 5
No contact with food or drink	◆	◆	◆
Not impair health/safety	◆	◆	◆
Clean & orderly manner	◆	◆	◆
Warning signs posted on storage buildings	◆	◆	◆
Warning signs posted on unattended vehicles	◆	◆	◆
Emergency telephone numbers posted	◆	◆	◆
Ventilated to outside		◆	◆
Limited access (locked)		◆	◆
No floor drain		◆	◆
Safety equipment available		◆	◆
Area used exclusively for pesticides			◆

Pesticide Spills

Protect yourself before you begin to clean up any spill. Clean up spills immediately.

In the case of minor spills:

- for liquids, cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite or dry soil. Sweep or shovel the material into a waste drum.

- for powders and granulars, sweep or shovel the material into a waste drum.

In the case of a major spill:

- remove any people or animals from the spill area
- stop the spill from spreading
- do not let the pesticide enter any watercourse.

For information on preventing spills see OMAFRA Factsheet, *Ways to Avoid Pesticide Spills*, Order No. 96-025. If a well becomes contaminated, follow the clean-up instructions in OMAFRA Factsheet *Pesticide Contamination of Farm Water Supplies*, Order No 00-099. (See inside front cover for information on how to order factsheets.)

If a pesticide spill causes, or is likely to cause, an adverse effect, you must notify the Ministry of the Environment, Spills Action Centre at 1-800-268-6060 (24 hrs a day, 7 days a week) and the municipality.

2. Pesticide Application

Using Sprayers

Always apply pesticides correctly. Incorrect application can waste pesticide, compromise control, damage crops (possibly your neighbours) and contaminate the environment. New equipment and control systems can make pesticide application simple and precise.

- Sprayers that deliver enough litres/hectare for adequate coverage are satisfactory for applying emulsion-type insecticides.

- If 2,4-D or related herbicides are used, clean the sprayers thoroughly with detergent containing ammonia to prevent crop damage.

- Adequate agitation is essential when applying wettable powder formulations.

- Make sure pumps are capable of delivering the flow and pressure required and are compatible with materials sprayed.

- Keep in mind that the higher the pressure, the greater the danger of drift to other crops.

- Calibrate your sprayer at least twice during the growing season with each set of nozzles used. The wear on nozzles and other parts alters the amount of spray delivered.

- Check all nozzles for flow rate at least once/year. Replace nozzles when their output is 10% greater than rated output.

- For information on calibration, see *Sprayer Calibration*, page 18, and *Air-Blast Sprayer Set-Up*, page 20. See also the calibration calculator on the OMAFRA Web site www.gov.on.ca/OMAFRA/english/ crops/sprayer/ep75.htm.

Sprayers for Home Use

Use a 9–14 L knapsack or compressed air garden sprayer.

- A nozzle tip producing coarse spray minimizes spray drift.

- Keep spray pressure low — it is easy to reach pressures of up to 700 kPa. High pressures produce smaller spray droplets that, in light winds, can drift to susceptible garden plants.

- Use a separate sprayer for herbicides.

Field Sprayers

Use boom-type sprayers for field pesticide applications. These sprayers apply pesticides evenly across the width of the boom. To spray fields effectively, always maintain:

- uniform spray pressure
- constant forward speed
- stable boom height (to assure uniform overlap of the nozzle tip patterns)
- appropriate application rates (L/ha) depending on the pesticide used.

Air Blast or Mist Sprayers

Never use air blast or mist sprayers to apply herbicides. They can cause herbicidal damage far from the target treatment area.

Wiper Applicators for Selective Weed Control

Wiper applicators (e.g., rope-wick, roller applicator) are commonly used with glyphosate (Roundup). Check product labels for information about using this technique with other herbicides. Labels list the crops for which wiper application is registered. To use wiper applicators:

- follow manufacturers' directions
- contact enough of the target weed to get herbicidal effectiveness
- keep the applicator above desirable vegetation to avoid crop injury
- maintain a vehicle speed of 4–10 km/hr
- make a second pass, especially in heavy weed infestations, or if using a higher vehicle speed
- avoid contact with sucker growth in orchards, vineyards and shelter belts.

Equipment Use and Care

Spraying Speeds

Uniform application rates require a constant forward speed whenever spray nozzles deliver liquid. If a tractor's driving wheels slip on the soil surface, the tractor's speedometer won't indicate a change in forward speed.

- To monitor forward speed despite wheel slippage on hills, use an independent speedometer with a ground driven wheel.

- Install spray monitors and other electronic rate controllers. These automatically correct for variations in tractor speed to maintain a constant application rate.

Using Water Correctly

- Mix pesticides with clean water that does not contain debris, sand or mud.

- Never let the water intake screen rest on a pond bottom when filling a sprayer.

- The water intake line near the screen must, by law, have a check valve or anti-backflow device. This prevents water-source contamination when the pump is shut off.

- Do not use a tank-refilling nozzle, volume-booster nozzle, or injection pump when refilling sprayer tanks from ponds or streams. These tank-refilling aids may contaminate the water source.

- When using a farm water supply, install a frost-free water hydrant outside the building. Place an anti-backflow valve/siphon preventor on the discharge end of the hydrant.

Agitation

You must return spray solution to the sprayer tank to provide hydraulic agitation within the tank.

- To be effective, the return or bypass line from the pressure regulator must deliver liquid to the tank bottom.

- Return 2–14 L/min. to the tank when applying chemical formulations in solution.

- Return 14–27 L/min. for each 450 L of tank capacity when spraying wettable powders. The appropriate rate depends on the wettable powder concentration and size of the tank. A dedicated line from the pressure side of the pump (not the pressure regulator) to the tank must be used to carry the liquid necessary for hydraulic agitation. Always use a venturi jet or sparge tube. Sparge tubes need more water than venturis to provide the same agitation. You can reduce the flow rate if the sprayer tank has a mechanical agitator.

Preparing a Wettable Powder and Oil or Emulsifiable Concentrate Mix

To prepare a tank mix of wettable powder and an oil or emulsifiable concentrate, follow these steps unless the product label states differently:

1. Fill the sprayer tank with water to the half full mark.

2. Start the agitator.

3. Add a premixed slurry of wettable powder and water.

4. Agitate for 2 minutes before adding more water.

5. Add the oil or emulsifiable concentrate last.

6. Do not over-agitate the mixture. It may become a grease-like mass that settles to the tank bottom. Over-agitation may also cause the mixture to foam excessively.

7. After any break from spraying, agitate the tank thoroughly before resuming.

8. To prevent oil buildup in the sprayer, empty the tank completely before refilling.

9. Clean the tank and sprayer with a detergent or solvent immediately after use, then flush thoroughly with clean water.

Soluble Packaging Options

Choose soluble packages that dissolve in the spray tank to reduce container disposal. Water-soluble packaging is used for dry flowable and wettable powder formulations of pesticides and is available under names such as Clean Pak, Solupak, and Toss-N-Go. In most cases, the water-soluble packaging material is PVA (poly vinyl alcohol). This material dissolves completely when added to the water in the sprayer tank according to instructions.

Read all labels and instructions carefully. For more details contact your vendor.

Keep soluble pouches dry until you add them to the spray tank.

- Do not handle pouches with wet hands or wet gloves.
- Do not remove pouches from the outer package until you are ready to add them
- Always reseal the outer package to protect the remaining pouches from moisture.

Mixing Soluble Pouches

- Consult product labels for specific mixing instructions for each product.
- Fill the spray tank ¼ full of water and have the agitator running — then add the water-soluble pouches to the tank.
- Most pouches dissolve completely within 5 minutes, depending on the water temperature and the degree of agitation.
- As the tank continues to fill, add any other compatible pesticides.

  Do not add:

  - a pesticide that is incompatible with the PVA packaging material. The PVA material is not soluble with summer-type oils (e.g., Superior Oil)
  - any material containing boron (e.g., Solubor), chelated micronutrients or water-soluble fertilizers. This combination is likely to cause a sticky, insoluble substance in the tank. If you apply boron, chelated micronutrients or water-soluble fertilizers, make sure that you completely empty and rinse the spray tank before you use any product packaged in PVA.

Pumps

Sprayer pumps must supply adequate capacity, pressure, volume and agitation for the task at hand.

- Use piston, diaphragm, or centrifugal pumps for wettable powder suspensions.
- Use any of the above plus roller pumps for liquid herbicide applications.
- Pumps used for wettable powders and flowable formulations need abrasion-resistant housings.
- Follow the manufacturer's care and storage instructions for optimum pump performance.
- Running a spray pump without water may cause premature wear or damage.

Nozzles

Accurate spray application requires high quality nozzle tips. They must emit a uniform spray pattern at an expected rate. You can purchase **machined orifice** and **moulded orifice** tips made from materials ranging from **brass, stainless steel**, and **hardened stainless steel** to non-metals such as **plastics/polymers** and **ceramics**. Choose an appropriate tip using the guidelines below and examine the tip's spray pattern before each use. When using boom-type sprayers maintain a stable boom height to assure uniform spray pattern overlap to prevent missed areas.

- All pesticide formulations cause orifice wear, especially wettable powders. Replace nozzle tips when they deliver 10% more spray than they did when new.
- Worn nozzle tips spray unevenly and can produce streaks across a field by delivering too much herbicide to a given area.

- Flushing water through the boom and nozzles does not remove pesticide residue buildup on the nozzles or screens. Always clean nozzle tips and screens thoroughly. Remove them from the nozzle body and wash with soap, water and a bristle brush.

Flat-Fan Nozzle Tips

- Flat-fan nozzle tips work well with boom-type herbicide sprayers. Flat-fan tips may be colour-coded for size (i.e., output). Some colour-coded tips have stainless steel, ceramic, or plastic/polymer inserts, or are used for specialized applications. Always read manufacturer's labels carefully.

- Set spacings, boom height and pressure as per manufacturer's recommendations. If not otherwise stated, maintain spray pressure at 275 kPa for standard elliptical-orifice flat-fan tips. (Some flat-fan nozzle tips operate at a reduced pressure of approximately 140 kPa. These tips reduce risk of drift.)

- Maintain a full overlap spray pattern by using 110-series of flat-fan nozzle tips (instead of 80-series tips) with the same 51 cm spacing and the same height as the 80-series tips. 110-series nozzles reduce misses should the boom bounce while traversing rough ground.

- You may obtain special "even-spray" nozzle tips for herbicide band applications. The nozzle's tip height, spray angle and orientation to the travelling direction combine to control the sprayed bandwidth. Follow manufacturers' directions closely.

Flooding-Fan Nozzle Tips

- Flooding-fan nozzle tips have a wide spray angle. They can be used closer to the ground, and at lower pressures, than flat-fan tips. This reduces drift.

- Flooding fan nozzle tips come in brass, plastic/polymers and stainless steel. They cover roughly twice the width as flat-fan nozzle tips. However, older designs tend to distribute herbicides less evenly than flat-fan tips. New turbo flood jets have an improved spray pattern.

Broadcast Nozzle Tips

- Broadcast nozzle tips cover a very wide swath.

- Use broadcast nozzle tips for lanes and fencerows where you don't need a uniform spray pattern.

- Never use a broadcast-type nozzle tip near a susceptible crop. The spray may drift severely with even a light breeze.

Full and Hollow Cone Nozzle Tips

Full or hollow cone nozzle tips are used primarily for high pressure application of insecticides and fungicides for horticultural crops. They can also be used to spray the soil surface when the herbicide is incorporated into the soil with a disk harrow, cultivator or similar tillage implement.

Nozzle Screens

You may obtain ball-check and plain nozzle screens. Ball-check screens use a check valve on each nozzle to minimize dripping from the boom.

- Never mix screen types in a spray boom, since different screen types produce different flow rates through the nozzle.

- Flushing water through the boom and nozzles does not remove pesticide residue buildup on the nozzle screens. Always clean nozzle screens thoroughly. Remove them from the nozzle body and wash with soap, water and a bristle brush.

Cleaning the Sprayer

- Clean sprayers immediately after spraying each day and whenever you change chemicals. Delaying even overnight allows persistent deposits to form.

- Don't neglect any sprayer parts. Clean the spray tank, booms, hoses, nozzles, tips, screens, filters, strainers and pumps. Be sure to remove every trace of pesticide.

- Cleaning techniques depend on the pesticide applied. Many pesticides list tank-cleaning information on the label — always follow these instructions. If necessary, contact the pesticide manufacturer to learn the best cleaning methods for a product. If you can't get specific cleaning instructions, use a strong detergent or alkaline cleaner. Then rinse thoroughly.

- Surfactants may remove pesticide residues from spray equipment. Be sure tanks containing herbicide/surfactant (e.g. Agral 90) mixtures are scrupulously clean. Otherwise, the mixture may remove residues from the spray equipment, adversely affecting the crop.

Environmental Issues when Cleaning

- Before cleaning the sprayer, you must safely dispose of any surplus tank mix. The Grower Pesticide Safety Course suggests diluting the remaining spray solution at least 1:10 with water. You can safely apply this diluted solution to the previously treated area if you don't exceed the maximum application rate on the product label.

- Equipment used with 2,4-D, MCPA or related phenoxy herbicides must never be used to spray other types of solutions on 2,4-D-susceptible crops or garden plants. Never store these products near greenhouses or other areas with susceptible crops.

- The wash water contains pesticides. Never allow wash water into a well, lake, pond, river or other water source.

Sprayer Calibration

Boom Sprayer Calibration

Field Boom Type Sprayer Calibration

(Determining application rates in L/ha)

There are many ways of determining the number of litres of spray material that are being applied to 1 ha of land — or calibrating a sprayer.

1. Measure the time.
   - Place 2 stakes 50 m apart in the field.
   - Select the gear and throttle setting (rpm) at which you plan to spray.
   - Fill the sprayer half full of water.
   - Drive the distance between the stakes 3 times, timing each pass. Each time, make sure the tractor is at the desired speed as you pass the first stake. Keep driving at this speed until you pass the second stake.
   - Take the average time of the 3 passes.

2. Measure the average nozzle output.
   - Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
   - Adjust the pressure regulator to the desired working pressure with full flow to the boom.
   - Collect the output from each nozzle for the average length of time needed to travel the 50 m in the test run.
   - Enter the nozzle outputs into the equation below.
   - If any nozzle is more than 5% above or below the average output, it should be cleaned or replaced.

3. Measure the nozzle spacing in metres.

4. Use the following formula to determine the sprayer output:

$$\begin{array}{c}\textbf{Sprayer Output}\\ \textbf{(Litres/Hectare)}\end{array} = \frac{\textbf{Average Nozzle Output (mL)}}{\textbf{Nozzle Spacing (meters)}} \times 0.2$$

5. Calculate the actual area sprayed after each tank of spray solution is applied. Recheck the actual sprayer calibration after each tank of spray is applied by dividing the volume sprayed by the actual area sprayed. The nature of some products may slightly alter the calibration from that of clean water.

6. Growers who prefer to measure in litres/acre or gallons/acre, can use the conversion factors found on page 19.

Band Spraying

If the sprayer has 10 nozzles and each nozzle covers a 36 cm (0.36 m) band, the total width of the spray patterns (swath width) is: 10 × 0.36 or 3.6 m.

Notes:

- Sprayer calibration bottles or kits are available from a number of suppliers. For further information contact the manufacturers of sprayers, sprayer parts or herbicides.

- For banded spray applications, measure the width of the spray band (at the soil surface or surface of the crop canopy) and enter this value into the formula instead of the "nozzle spacing". Where band spraying, the acreage sprayed is not the same as the crop acreage. Unless otherwise stated, the herbicide rates referred to in most herbicide publications and labels refer to the actual area sprayed.

Conversion Factors

L/ha × 0.4 = L/acre
L/ha × 0.11 = U.S. gal/acre
L/ha × 0.09 = Imp. gal/acre

Sample Calculation

Time to travel 50 metres (164 ft.):	24.5 seconds
Liquid collected/nozzle for 24.5 sec:	525 mL
Nozzle spacing on the boom:	0.5 metres

Application Rate: $\frac{525\text{ mL}}{0.5\text{ m}} \times 0.2 = 210\text{ L/ha}$

Conversions

210 L/ha × 0.4 = 84 L/acre
210 L/ha × 0.11 = 23 U.S. gal/acre
210 L/ha × 0.09 = 18.9 Imp. gal/acre

Guide for Spraying Fruit Trees

General Considerations

- The sprayer must be large enough to cover the orchard in the time available and under adverse conditions.
- Equipment must be in top condition.
- Trees must be pruned so the spray penetrates easily.
- Weather conditions must be monitored, and the orchard scouted routinely for disease, insect pest numbers and stages, so that spray timing is accurate.

Calculating Water Volume and Pesticide Rates

Water Volume for Dilute Sprays:

Dilute sprays are applied in enough water volume to wet all foliage to the point of run–off. Although growers rarely use dilute sprays, you should know the amount of water required to spray each block of orchard dilute. For trees 4.5 –5.5 m high, this is approximately 3000 L water/ha. (See Table 2–1, *Water Volume Guidelines Based on Tree Row Volume.*)

Water Volumes for Special Pests:

Special pests include scale insects, overwintering mite eggs, and other pests that are relatively immobile. Use enough spray liquid to soak the bark completely. When spraying streptomycin for fire blight, higher volumes are also required for maximum absorption of material. Suggested volumes of water for special pests are listed in Table 2–1.

Water Volumes for Routine Pesticide Applications:

Choose a water volume that provides even spray coverage using your application equipment, for your tree size. Consider the target pest.

Using lower water volumes to apply pesticide takes less time and less water. However, excessively low-volume applications often result in poor control of scale insects, mites and woolly aphid, especially in tree tops.

Many growers adjust the water volume and rate of pesticide applied in different blocks by turning off certain nozzles, or by adjusting driving speed. This allows growers to spray different orchard blocks, of different tree sizes, while maintaining the same amount of chemical in each full tank of water.

TABLE 2–1. Water Volume Guidelines Based on Tree Row Volume

Tree Height	Pesticide/ha	Water/ha for Dilute Spraying	Water Volumes for Special Pests
6 m and over	1 1/3 × recommended rate	4000 L	4500 L
4.5–5.5 m	full recommended rate	3000 L	4000 L
2.5–3 m	2/3 × recommended rate	2000 L	3500 L

Pesticide Rates:

Fruit trees change in size considerably from the time they are planted to when they reach maturity. Rootstocks and variety also affect the size of a tree, and the volume of the tree canopy.

Rates on pesticide labels are based on mature trees. An assumption has been made that mature trees are 4.5–5.5 m high, and require a water volume of 3000 L/ha for dilute spraying. Growers can adjust rates for canopy volumes that require more, or less, than 3000 L/ha of water for a dilute application. (See Table 2–1).

Note: Companies are not liable for pest control failures due to use of rates below those recommended on their labels.

Table 2–1 recognizes that effective coverage of smaller tree canopies can be achieved when using a lower volume of spray solution. The method of calculating spray volume requirements for tree canopies is referred to as tree row volume. For further explanation and instruction on tree row volume, refer to OMAFRA Factsheet, *Guide for Spraying Fruit Trees*, Order No. 03-035 or Publication 310, *Integrated Pest Management for Ontario Apple Orchards*.

Air-Blast Sprayer Set Up

Refer to Table 2–2, *Spraying Time per Hectare*. Proceed through the following 7 steps.

1. Check tractor speed. (See Table 2–3, *Time Required to Pass a Number of Trees at Different Driving Speeds*, on page 21.)
2. From Table 2–2 find the number of minutes needed to spray a hectare at the speed recommended for your sprayer.
3. Decide how many litres of liquid/hectare you wish to use (considering time available, size of sprayer, size of trees, and time of day spraying will be done). The use of tree row volume can help determine the spray volume required.
4. Find the sprayer output required:

   litres/hectare ÷ time/hectare = litres/minute (for all nozzles)

5. Divide the output by the number of nozzles:

   litres/minute ÷ number of nozzles = litres/minute (per nozzle)

6. From manufacturer's nozzle charts, find a nozzle to give this output at the selected operating pressure. Then choose nozzles with smaller outputs for top and bottom positions and larger ones for the upper third of each side. When added, the total output should be close to the value shown in step 4 (L/min). For small trees, block off 1 or 2 of the top nozzles and shut off between trees to prevent waste of spray.
7. After the nozzles have been selected, calibrate the sprayer. Fill the tank with water and spray for 3 minutes. Use a flow-metering device or a pail calibrated in litres to refill the tank to its original level. The amount required to refill the tank should equal the litres/minute calculated in step 4, times 3 minutes.

Pesticide Injury to Crops

Although insecticides and fungicides have been selected and formulated to avoid plant injury, damage can still occur under some conditions. Observe the following precautions.

- Apply sprays when the drying condition is fast. Some chemicals break down to components that are injurious to plant tissues if permitted to stay wet.

TABLE 2–2. Spraying Time per Hectare (Without Turning and Filling Time)

Distance between rows (metres)	Tractor Speeds (km/hr)						
	1.6	2.4	3.2	4.0	4.8	5.6	6.4
	Time (in minutes) to Drive One Hectare						
3.1	125	82.5	62.5	50	41.25	35	31
4.6	82.5	55	41.25	33	27.5	23.5	20.5
6.1	62.5	41.25	31	25	20.5	17.75	15.5
7.6	50	33	25	20	16.5	14	12.5
9.1	41.25	27.5	20.5	16.5	13.75	11.75	10.25
10.7	35.25	23.5	17.75	14	11.75	10	8.75
12.2	31	20.5	15.5	12.5	10.25	9.5	7.75

TABLE 2–3. Time Required to Pass a Number of Trees at Different Driving Speeds

Tractor Speed (km/hr)	In the Row Tree Spacings (meters)							
	1.6	3.1	4.6	6.1	7.6	9.1	10.7	12.2
	Time (seconds) to pass 10 trees							
2.4	23	45	68	91	114	136	159	182
3.2	18	34	51	68	85	102	119	136
4.0	14	27	40	54	68	82	95	109
4.8	12	23	34	45	58	70	82	94
5.6	10	19	27	39	49	58	68	78
6.4	9	17	26	34	43	51	60	68

- Apply sprays when temperature is below 27°C. The spray deposits serve as a lens and concentrate the heat on the plant tissues.

- Be particularly careful when plants have been under growth stress such as prolonged periods of drought, excessive cloud cover, extremely low or high temperatures.

- Apply sprays soon after mixing. Undesired chemical change may take place with some chemicals if the sprays remain in the tank for prolonged lengths of time (e.g. overnight). In other cases, the chemicals may settle out and clog the lines.

Compatibility of Spray Materials

For information on compatibility of spray materials, **always check the product label**. Compatibility may refer to the physical or chemical compatibility of 2 products in solution.

Physical incompatibility: combinations result in a physical change in the solution. Components of the combined product may plug nozzles, or become solidified or gummy in the tank.

Chemical incompatibility: can result in chemical changes in the spray solution that can lead to reduced efficacy, or can cause plant injury when sprayed on the crop. The results of a chemical incompatibility may not be evident until after the spray is applied.

In general

- Compatibility of 2 products may vary with the formulation of those products. For example, 2 products may be compatible as Wettable Powder (WP) formulations, but the same active ingredient may not be compatible as Emulsifiable Concentrate formulations (EC's).

- Compatibility generally refers to 2-way mixtures. Adding a 3rd product to a tank mix, even if all are compatible with each other in 2-way combinations, may result in further incompatibility.

- Compatibility of some materials may depend on the solvents and emulsifiers used by the manufacturer. EC's are more likely to cause compatibility problems than WP's. If WP's are mixed with EC's, incompatibilities may result.

Specifically

- When mixing Captan or Maestro with EC formulations of pyrethroids, add Captan or Maestro first. Apply immediately with constant agitation.

- Do not mix pesticides with lime sulfur or with Streptomycin.

- Do not use oil sprays within 14 days of Captan, Maestro, Captan combinations or Morestan. This applies also to the oil used with Agri-Mek.

- Water soluble, polyvinyl alcohol packaging (PVA) material is not compatible with Superior Oil, or EC formulations containing mineral or vegetable oil products.

- Water-soluble packaging is not compatible with boron, and some chelated micronutrients or water soluble fertilizers. Rinse the spray tank carefully after application of these nutrients, before using products in water-soluble packages.

- For more information on compatibility, contact the product manufacturer or dealer. See Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266 to find the manufacturer's/agent's code for the products you want to mix. Use Table 13–4, *Pest Control Product Companies*, on page 280 to find contacts for more information.

Aerial Application by Airplane or Helicopter

Any person who applies pesticide from an aircraft in Ontario **must** hold an aerial exterminator licence. In addition, a permit is required to purchase and apply pesticides by air for the following:

- applications to surface water, e.g. ponds, lakes, rivers (exceptions in some cases)
- applications to forests as defined in the *Crown Forest Sustainability Act*
- applications of any Schedule 1 or 5 pesticide or a Schedule 2 pesticide containing 2,4-D, 2,4-DB, mecoprop, MCPA, MCPB, dichlorprop, dicamba, picloram, paraquat or trichlopyr except when applications are made to agricultural land.

Be sure that any pesticide you apply by air has specific instructions for aerial use on the label.

Take extra precautions when using insecticides applied by air that are toxic to honeybees, such as Sevin (carbaryl).

Pesticide Drift

Pesticide drift can leave residues on adjacent crops, be a hazard to nearby people and livestock, and reduce the amount of material in the target area so that it is ineffective. Minimize or prevent pesticide spray drift by:

- correctly calibrating and maintaining spray equipment
- operating the equipment correctly
- being aware of weather conditions.

Growers are responsible for material discharged from their sprayers no matter where it is found. This includes liability for adverse affects such as damage to crops or to ornamental plants and illegal or unacceptable residue on neighbours' crops or property. You could also be responsible for injury resulting from car accidents caused by windows smeared by spray drift or allergic or asthmatic reactions of bystanders, even if they are not on your property. Take all precautions necessary to prevent drift off site that might implicate you in any damaging action.

For more information consult the Best Management Practices book, *Pesticide Storage, Handling and Application* and *Integrated Pest Management* available from the Ontario Federation of Agriculture, tel: 416- 485-3333, e-mail: genny.kinapen@ofa.on.ca.

3. Soil Management, Cover Crops and Fertilizer Use

For a complete guide to soil fertility, consult OMAFRA Publication 611, *Soil Fertility Handbook.*

Soil Testing

Ontario currently uses almost 690,000 tonnes of fertilizer annually. High yields can only be produced efficiently when fertilizer use is related to:

- fertility level of the soil
- additions of nutrients from manure
- crop residues
- other organic sources.

At one extreme, on very low fertility soils, it can be profitable to add as much or more nitrogen, phosphorus or potassium to the soil as a crop removes. But on high fertility soils, or following heavy application of manures, fertilizer may not be profitable, and occasionally may reduce yields.

Why Soil Test?
Soil tests accredited by OMAFRA are an accurate tool for Ontario farmers to determine the amount of phosphorus, potassium and magnesium fertilizers, and lime to apply for crop production. Always take a soil test well in advance of establishing perennial fruit crops. Always ask for OMAFRA-accredited soil tests.

Other Methods of Assessing Nutrient Needs

Plant tissue analysis is routinely used for tree fruits and several berry crops. Plant analysis can provide additional information supporting the soil test for field and vegetable crops.

In some cases, *nutrient deficiency symptoms* on crop leaves help assess deficiencies. However, this method is not always appropriate for determining potassium and phosphorus levels, because yield losses can be significant before deficiency symptoms appear.

It is possible to apply the amounts of nutrients removed by a specific crop. This works with nitrogen, since there are some crops where the suggested rate approximates what the plant removes. But it does not apply for other nutrients in Ontario. Some clay and clay loam soils have sufficient potassium to last many years. Applying potassium each year on those soils is not cost effective. One of the few advantages clay soils have over coarser-textured soils is their ability to store potassium.

Use the OMAFRA-accredited soil testing program, along with plant analysis and nutrient deficiency symptoms, to determine fertilizer requirements for a specific crop on a specific field.

Benefits of the OMAFRA-Accredited Soil Testing Program

The OMAFRA-accredited soil testing program recommends application rates of nitrogen, phosphate, potash and magnesium, as well as the amount and type of lime required. (See Table 3–1, *OMAFRA-Accredited Soil Tests,* page 24.) The OMAFRA recommended fertilizer rates are provided in this publication. They are designed to produce highest economic yields when accompanied by good or above average management. Refer to Appendix B, *Tissue Testing and Accredited Soil Testing Laboratories in Ontario,* on page 284 for a list of accredited labs in Ontario.

Use OMAFRA-accredited soil tests to provide accurate fertilizer recommendations. Be certain that the service you use is accredited. To be accredited, a laboratory must use OMAFRA-approved testing procedures, must demonstrate acceptable analytical precision and accuracy, and provide the OMAFRA fertilizer recommendations.

TABLE 3–1. OMAFRA-Accredited Soil Tests*

Materials Analyzed	What is Analyzed[1]
Soils for crops, commercial turf, etc.	Plant-available phosphorus, potassium, magnesium, manganese and zinc; pH; lime requirement
Greenhouse media	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts
Nutrient solutions, water	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts; sulphates; chlorides

* See Appendix B for a list of OMAFRA-accredited laboratories.

[1] Soil organic matter can be useful for herbicide recommendations, but it is not an accredited test.

A number of laboratories provide soil tests that include exchange capacity, aluminum and copper. These are not accredited by OMAFRA because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils, using exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided. See Appendix B, page 284.

Soil Sampling

Sample soils with a sampling tube or shovel. Sample each field, or uniform section of a field, separately. Take at least 20 soil cores, 15 cm deep, from any field or area sampled up to 5 ha in size. For fields larger than 5 ha take proportionately more cores. The more cores taken the more likely the soil sample will provide a reliable measure of the fertility in the field. One sample should not represent more than 10 ha.

Collect soil in a clean pail. Break up lumps, mix the soil well and place in a soil sample box. Traverse the area in a zigzag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ in appearance of soil or crop, or parts of the field that were limed, fertilized, or treated with manure differently than the rest of the field, should be sampled separately. Sample these areas separately even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

Sample each field once every 2 or 3 years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and are not returned. Under these conditions sample yearly.

Analysis takes time. Ideally, take soil samples the previous fall from fields to be fertilized for spring planting. You may also take soil samples in summer.

Management practices that affect a soil test recommendation are manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation. Remember to record it on the field information sheet that must accompany the soil sample sent for analysis.

Testing Soil for Micronutrients

OMAFRA-accredited soil tests are available for manganese and zinc, however, plant analysis and using visual symptoms are also useful. OMAFRA-accredited soil tests are not available for boron, copper, iron, or molybdenum. Plant analysis is generally a better indicator of deficiencies of these nutrients.

Micronutrient deficiencies or pH problems frequently occur in small patches in fields. In these cases, soil or plant analysis taken from the entire field are unlikely to find the problem. Sample problem areas separately.

Great care is required to prevent contamination of soil samples with micronutrients, particularly zinc.

- Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests.
- Do not use metal containers to collect and mix samples.
- Use clean plastic containers in good condition.
- Soil samples that have contacted galvanized surfaces are unsatisfactory for zinc soil tests.
- Be careful to keep dust around buildings etc. out of the samples.

Plant Analysis

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the *normal* and *critical* values for the crop can indicate whether the nutrient supply is adequate for optimum growth.

Plant analysis is the basis of fertilizer recommendations for tree fruits and grapes, and is presently recommended for apples, pears, plums, peaches, sour cherries, grapes (petiole analysis), strawberries, blueberries and raspberries. Plant analysis is a well-established procedure and standards exist for accurate interpretation. Refer to OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

Plant analysis is also a useful supplement to soil testing for evaluating the fertility status of other crops. It is independent of soil testing and can provide a valuable second opinion, especially for phosphorus, potassium, magnesium and manganese. It has not been very reliable for nitrogen and zinc. There is no reliable soil test for boron and copper, so use plant analysis and visual symptoms to diagnose deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not usually indicate the cause of a deficiency or the amount of fertilizer required to correct it.

Sampling

Time of sampling has a major effect on plant analysis results because nutrient levels within a plant vary considerably with the age of the plant. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, sample plants suspected of being nutrient deficient as soon as a problem appears. Take samples from a problem area, plus an adjacent healthy area for comparison.

Take samples from at least 20 plants distributed throughout the sampling area. Each sample should consist of at least 100 grams of fresh material. Sample problem areas separately. Do not contaminate the sample with soil. Even a small amount of soil invalidates the results, especially for micronutrients.

Sample Preparation

Deliver samples of fresh plant material directly to the laboratory. If not delivered immediately dry your samples to prevent spoilage. They can be dried in an oven at 65°C or less, or in the sun, provided you take precautions to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several accredited laboratories in Ontario. (See Appendix B.)

Fertilizer Recommendations

See also:

Apple Nutrition .... page 61–68
Berry Crop Nutrition .... page 96–102
Grape Nutrition .... page 129–133
Tender Fruit Nutrition .... page 145–150

Nitrogen

Nitrogen fertilizer recommendations for fruit crops are based on estimated crop requirements, and for tree fruits and grapes, on tissue analysis. Recommended rates are presented in the fertilizer section for each crop. Rates are adjusted downward if manure is applied or if the previous crop contains perennial legumes, such as alfalfa.

To protect crop quality and avoid surface and groundwater pollution, make sure the combined application of fertilizer, manure, biosolids and other sources of nitrogen does not supply plant-available nitrogen in excess of the crop's requirement.

Phosphate and Potash

Phosphate and potash recommendations are based on OMAFRA soil tests. Recommended amounts for each fruit crop are provided in the chapter specific for each crop. Use these tables only with OMAFRA-accredited soil tests. Non-accredited tests may use extractants that pull out different amounts of nutrient, so they will not give correct answers if used with the OMAFRA tables.

Where a soil test is not available, a rough estimate of requirements can be obtained using the following guidelines:

- Where a field was fertilized regularly for years or heavily in recent years, use one of the rates of phosphate and potash recommended for the medium soil test rating.

- If a field has received little fertilizer in the past, use one of the rates recommended for a low soil test rating.

Soils that test excessive for phosphorus contain more plant-available phosphorus than is required by most crops. Applying additional phosphorus — whether from fertilizer, compost, manure or sewage biosolids — is unlikely to provide a yield increase, and may interfere with availability and uptake of other nutrients.

The rating system for soil test phosphorus evaluates the likelihood of a crop response to applied phosphorus. The risk of surface water contamination by phosphorus is affected by:

- soil test phosphorus levels
- the movement of soil and phosphorous bound to soil particles, from a field by erosion.

Because of this, the risk of surface water contamination by phosphorus cannot be based on a soil-test phosphorus level alone.

Wherever soil tests are very high or excessive, applications of any source of phosphorus should be guided by a phosphorus index. (See OMAFRA Factsheet *Determining the Phosphorus Index for a Field*, Order No. 98-079.*)* A phosphorus index can rank the relative risk of surface water contamination for applications made to a particular area of land. It also determines maximum application rates if manure is applied, and required setbacks from watercourses.

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

Changes In Crop or Management That Affect Fertilizer Recommendations

Fertilizer recommendations on the OMAFRA soil test report are for specific crops using specific management practices.

- Use Table 3–5, *Average Amounts of Available Nutrients for Different Types of Manure*, on page 29 to adjust fertilizer recommendations following a change in manure application.
- Use Table 3–6, *Adjustment of Nitrogen Requirements where Crops Containing Legumes are Plowed Down*, on page 30 to make adjustments for legumes plowed down.
- If the crop is changed, get a new recommendation by finding the appropriate table for that specific crop.

Soil Acidity and Liming

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most crops grow well in a soil pH range from 6.0 to 8.0.

To correct soil acidity, broadcast ground limestone and work it into the soil at rates determined by a soil test. Table 3–2, *Soil pH at which Lime is Recommended for Ontario Crops*, on page 27 shows the pH values below which lime is recommended and the target soil pH to which soils should be limed, for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

The Buffer pH

Different soils with a similar soil pH value will require different amounts of lime to bring the pH to a particular desired level, depending chiefly on the clay and organic matter content of each soil. The soil pH determines which soils need to be limed. But a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH) use Table 3–3, *Lime Requirements to Correct Soil Acidity based on Soil pH & Soil Buffer pH*, on page 28 to determine the amount of lime required to reach different target soil pH values required for different crops.

Limestone Quality

Calcitic limestone consists largely of calcium carbonate. **Dolomitic limestone** is a mixture of both calcium and magnesium carbonates.

- *On soils with a magnesium soil test of 100 or less:* Use dolomitic limestone. It is an excellent and inexpensive source of magnesium for acid soils.
- *On soils with magnesium tests greater than 100:* Use calcitic or dolomitic limestone.

TABLE 3–2. Soil pH at which Lime is Recommended for Ontario Crops

Crops	Soil pH below which Lime is recommended	Target Soil pH*
Coarse and Medium-Textured Mineral Soils (sand, sandy loams, loams and silt loams)		
Perennial legumes, oats, barley, wheat, beans, peas, canola, flax, tomatoes, raspberries, strawberries, new plantings of tree fruits or grapes, all other crops not listed below (except blueberries)	6.1	6.5
Corn, soybeans, rye, grass, hay, pasture, tobacco	5.6	6.0
Potatoes	5.1	5.5
Fine-Textured Mineral Soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
Other perennial legumes, oats, barley, wheat, soybeans, beans, peas, canola, flax, tomatoes, strawberries, raspberries, new plantings of tree fruits or grapes, all other crops not listed above or below (except blueberries)	5.6	6.0
Corn, rye, grass, hay, pasture	5.1	5.5
Organic Soils (peats and mucks)		
All field and vegetable crops	5.1	5.5

* Where a crop is grown in rotation with other crops requiring a higher pH (e.g. corn in rotation with wheat or alfalfa), lime the soil to the higher pH.

Two factors affect the value of limestone for soil applications:

- **neutralizing value** and
- **particle size**.

Neutralizing value is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. It is expressed as a percentage of the neutralizing value of pure calcium carbonate. Limestone that neutralizes 90% as much acid as pure calcium carbonate has a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

The second factor affecting the value of limestone as a neutralizer of acidity is **particle size**. Limestone rock has much less surface area to react with acid soil than finely powdered limestone; therefore it neutralizes acidity much more slowly — so slowly it is of little value. The calculation of a fineness rating for ground limestone is illustrated in Table 3–4, *Example Calculation of the Fineness Rating of Limestone*, on page 28.

The Agricultural Index

Some means of combining the neutralizing value and the fineness rating is needed to compare various limestones available. The index developed in Ontario to do this is the **agricultural index**.

The agricultural index compares the relative value of different limestones for neutralization of soil acidity. Lime with a high agricultural index is worth proportionately more than lime with a low index because it may be applied at a lower rate.

For example, suppose 2 ground limestones, A and B, have agricultural indices of 50 and 80 respectively. The rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the OMAFRA soil test service are based on limestone with an agricultural index of 75. If you purchase lime with an agricultural index other than 75, you can calculate a rate of application specifically for that limestone. You must know the agricultural index of the lime you purchase. Use the following equation:

$$\text{Application rate} = \frac{75}{\text{agricultural index}} \times \text{(application rate from soil test)}$$

TABLE 3–3. Lime Requirements to Correct Soil Acidity based on Soil pH & Soil Buffer pH

Buffer pH	Target soil pH = 6.5[1]	Target soil pH = 6.0[2]	Target soil pH = 5.5[3]
Ground limestone required t/ha (based on an Agricultural Index of 75)			
7.0	2	1	1
6.9	2	1	1
6.8	2	1	1
6.7	2	2	1
6.6	3	2	1
6.5	3	2	1
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	8	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

[1] Lime if soil pH below 6.1
[2] Lime if soil pH below 5.6
[3] Lime if soil pH below 5.1

TABLE 3–4. Example Calculation of the Fineness Rating of Limestone

Particle Size	% of Sample	Effectiveness Factor
Coarser than #10 sieve[1]	10	× 0 = 0
#10 to #60 sieve	40	× 0.4 = 16
Passing through #60 sieve	50	× 1.0 = 50
Fineness rating		= 66

[1] A #10 Tyler sieve has wires spaced 2.0 mm, and a #60 Tyler sieve has wires spaced 0.25 mm apart.

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an agricultural index of 90, apply 75/90 × 9 = 7.5 t/ha.

The agricultural index does not provide information about magnesium content. Use dolomitic limestone on soils low in magnesium.

Tillage Depth

Lime recommendations presented here should raise the pH of the top 15 cm of a soil to the listed target pH. If the soil is plowed to a lesser or greater depth than 15 cm, proportionately more or less lime is required to reach the same target pH. Where reduced tillage depths are used, reduce the rates of application proportionately. More frequent liming will be needed.

Lowering Soil pH

On soils with pH values below 6.5 you can lower the pH (make the soil more acid) by adding sulphur or ammonium sulphate. This is not advisable for most crops, as it only hastens the time when lime will be required. If the soil pH is above 6.5, it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulphur or ammonium sulphate required.

Managing Soil Organic Matter

Soil organic matter helps:

- maintain soil structure and tilth
- improve soil moisture holding capacity
- increase the soils ability to hold nutrients
- improve internal drainage.

Maintaining adequate soil organic matter levels can help maintain crop yields, particularly in years with bad weather.

Increasing soil organic matter is a slow process. Only a small part of organic matter added to the soil becomes stable humus. It is important to keep as much organic matter in the soil as possible by:

- reducing soil erosion
- eliminating unnecessary runoff
- avoiding excessive tillage.

Organic matter additions also, over time, increase the total soil organic matter. These may be in the form of livestock manures, biosolids, forage crops or cover crops. Cover crops recommendations for fruit crops are discussed in *Cover Crops and Ground Cover Management*, page 35 and at www.gov.on.ca/OMAFRA/english/crops/facts/cover_crops01/covercrops.htm.

Manure is an important organic amendment that contains considerable amounts of nitrogen and potassium, and smaller amounts of available phosphorous. When using manure, reduce fertilizer rates as indicated either in Table 3–5, *Average Amounts of Available Nutrients for Different Types of Manure* or based on an analysis of the manure nutrient content. Do not ignore the nutrients added in manure or other organic sources. Excess nutrient application can reduce crop quality, or increase environmental risk.

Biosolids derived from paper mill fibre have been used in orchards and vineyards to maintain soil organic matter. Before this material can be applied to land, you must have a Certificate of Approval issued by the Ontario Ministry of the Environment (MOE) for the site. Rates can be in the range of 25–30 dry t/ha but will vary according to the nitrogen content of the material. The MOE has final approval of the material and the applied rate. Any application restrictions are included as conditions on the Certificate of Approval.

Sewage biosolids are a source of nitrogen, phosphorous and organic matter. As with paper mill fibre, a Certificate of Approval is required for the site receiving sewage sludge. Before sewage sludge can be applied to land it must qualify under the MOE guidelines. These guidelines place restrictions on the types of crops receiving sewage sludge and the waiting periods between application and harvest. For tree fruits and grapes the waiting period is 3 months. The required waiting period between sewage sludge application and small fruit (strawberries, raspberries and blueberries) harvest is 15 months. For more information refer to OMAFRA Factsheet *Land Application of Sewage Biosolids for Crop Production*, Order No. 00-023.

Some processing companies that contract crops may have concerns about sludge applications to fields where certain crops are grown. Please contact companies prior to spreading sewage sludge to confirm they will accept your crop.

Straw and spoiled hay are other excellent sources of organic matter. As manure becomes more costly and difficult to obtain, straw or hay will be more widely used. Seven tonnes per hectare of straw or old hay will supply approximately the same amount of dry matter as 22 t/ha of cattle manure.

TABLE 3–5. Average Amounts of Available Nutrients for Different Types of Manure[1]

Manure	Average Dry Matter	Available Nitrogen[2] Spring 1 day	Available Nitrogen[3] Spring not incorp.	Available P_2O_5 [4]	Available K_2O [5]
			kg/1,000 L (lb/1000 gal)		
Liquid dairy	6.5%	1.6 (16)	0.6 (6)	0.7 (7)	3 (30)
Liquid hog	3.6%	2.6 (26)	0.7 (7)	1.1 (11)	2 (20)
Liquid poultry	8.0%	6.1 (61)	1.7 (17)	2.5 (25)	3.4 (34)
Liquid biosolids (sludge)[6]	4.4%	1.2 (12)	0.6 (6)	1.3 (13)	0.2 (2)
			kg/tonne (lb/ton)		
Solid biosolids	36%	1.5 (3)	0.75 (1.5)	11 (22)	0 (0)
Solid poultry	49%	11.5 (21)	6 (12)	9 (18)	12.5 (25)
Solid dairy	20%	1.5 (3)	0.7 (1.4)	1.5 (3)	4.8 (9.7)
Solid beef	28%	1.5 (3)	0.75 (1.5)	2.1 (4.2)	6.1 (12.3)

[1] Nutrient values based on average analysis results for over 700 samples. There are large variations between different manures, so a manure analysis is your best guide to nutrient availability.

[2] Nitrogen based on spring application, incorporated within 24 hours.

[3] Nitrogen based on spring application, not incorporated (i.e. on soil surface for over 7 days).

[4] Phosphate from manure or biosolids is assumed to be 40% as available as that in manufactured fertilizer in the year of application.

[5] Potash from manure or biosolids is assumed to be 90% as available as that in manufactured fertilizer in the year of application.

[6] For biosolids (e.g. sewage sludge), you must get a certificate of approval from your local MOE office. This can take up to 6 months.

Fertilizer Adjustments for Legumes Plowed Down

When perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. Unfortunately, the rate of release is variable, and depends on soil and weather conditions. Late release of nitrogen may pre-dispose fruit crops to winter injury. If perennial legumes are grown prior to planting fruit crops, use Table 3–6, *Adjustment of Nitrogen Requirements where Crops Containing Legumes are Plowed Down* to adjust nitrogen fertilizer applications.

TABLE 3–6. Adjustment of Nitrogen Requirements where Crops Containing Legumes are Plowed Down

Type of Crop	For all crops deduct from N requirement kg N/ha
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	100
Perennial legumes seeded and plowed in same year	45[1]
Soybean and field bean residue	0

[1] Applies where the legume stand is thick and over 40 cm high.

Fertilizer Adjustments Following use of Manure

Ontario livestock farms generate over 33 million tonnes of manure. Proper management of nutrients from manure is essential for optimum economic benefit to the farmer with minimal impact on the environment.

The value of manure in crop production is often underestimated. Manure contains all nutrients needed by crops but not necessarily in the proportions needed for specific soil and crop conditions. In addition to nitrogen, phosphorus and potash, manure contains many secondary and micronutrients, as well as organic matter that helps build and maintain soil structure.

Manure Analysis

Manure analysis is necessary because the quantities of nutrients contained in manure, especially phosphorus and potash, vary from farm to farm. The following factors affect nutrient content of manure:

- type of livestock
- ration
- bedding
- added liquids
- manure storage system

Manure analysis is available from several soil-testing laboratories in Ontario. (See Appendix B, page 284.) Perform a manure analysis after complete agitation or thorough mixing, each time the storage is emptied (e.g. spring and fall). After several analyses, a trend develops and you can limit sampling to major changes in ration or other management factors.

When sending a sample to the lab, fill a plastic jar (about 2 L capacity) half-full, cover and place in a plastic bag. Store the sample in a cool place until shipping. Analysis should include total nitrogen, ammonium-nitrogen (NH_4-N), phosphorus, potassium and dry matter. Ontario labs send back analysis results with percentages for nitrogen, phosphorus, potassium and dry matter as well as mg/kg (or ppm) of ammonium-nitrogen. Percentages for phosphorus and potassium from manure are converted to commercial P_2O_5 and K_2O equivalents and commercial fertilizer reductions are given.

For more information on manure analysis, the available nitrogen in manure, and calibrating manure spreaders, see OMAFRA Publication 611, *Soil Fertility Handbook*.

Long Term Value of Manure

The long-term availability of phosphorus (P), potassium (K), magnesium, zinc or manganese from previous manure applications is best estimated by soil testing. Application of large quantities of manure over time can result in high levels of available P and K in soils. Manure also contributes other plant nutrients and organic matter to soil that may be of some long term value.

Most of the available nitrogen in manure is used by the crop or lost during the first growing season following application. The remaining organic nitrogen becomes available in small, diminishing quantities in succeeding years. Generally the amount of residual nitrogen from one application is too small to make a practical difference in nitrogen recommendations for a crop. However, where manure is applied regularly to the same field, there can be significant residual nitrogen available for a crop. Use the soil test for P and K to measure residual phosphorus and potassium from manure applications.

Environmental Concerns with Manure

Using manure to meet, but not exceed, crop nutrient needs helps to minimize nutrient losses to the environment. However, take care to avoid manure contamination into streams from erosion, surface and tile runoff.

Do not spread manure in the winter and early spring because of the potential for runoff to surface water. The fate of the first meltwater following manure application determines whether this will be a problem or not. This practice should not be a part of a nutrient management plan. In years when winter spreading may be necessary, select fields where there is no risk of runoff to surface water.

Rain can cause organic nitrogen to wash into streams if manure has been applied to unprotected cropland.

Phosphorus, attached to soil particles, can be carried to streams by soil erosion. Conservation practices can reduce the chances of nutrients polluting waterways.

Do not spread liquid manure within 10 m of a watercourse (5 m for solid manure) or more if the phosphorus index is high.

Flow in tile drains can become contaminated if manure enters a catchbasin or travels through soil cracks to the tiles. When using liquid manure, maintain a 10 m buffer around a catchbasin or surface inlet (5 m with solid manure). If there is any history of tile contamination via soil cracks or macropores, tillage prior to application is recommended.

Applying nutrients in manure or fertilizer in excess of crop requirements can contaminate groundwater, particularly on shallow soils over bedrock, soils with a water table close to the surface, or very sandy soils where leaching is a concern. Groundwater contamination can occur by mass flow through cracks and holes to groundwater, or through leaching of nitrates through the soil.

Food Safety Concerns with Manure Application and Timing

Fruit and vegetable crops can become contaminated in the field if they contact microbes that cause human disease. These microbes can come from manure fertilizers and manure-based composts. They can contaminate fruit or vegetables by direct soil-to-produce contact or through rain-splashed soil. Examples of harmful microbes are some, but not all, strains of *E. coli, Salmonella, and Campylobacter.*

The longevity of harmful microbes in manure is not well known. Proper composting of manure, which results in heating to a specific temperature for a specific period of time, reduces the level of most pathogens. Aged manure (manure stored in piles and sometimes turned) may contain considerably more pathogens than properly composted manure (manure turned/mixed frequently, temperature monitored and maintained). Composting may not completely eliminate all pathogens. Take appropriate precautionary measures. Incorporation of manure will minimize, but may not eliminate, the risk of microbial contamination of produce.

Manure application to fruit and vegetable crops is not recommended before harvest, in the year of harvest.

Concerns about food safety and the possible introduction of food borne pathogens to windfall apples by application of manure to the orchard floor is discussed in the *Code of Practice for the Production and Distribution of Unpasteurized Apple and Other Fruit Juice/Cider in Canada*. Where apples may be used for juice or cider, it may not be appropriate to apply fresh or composted manure to the orchard. Food borne pathogens can be introduced into orchards via manure and these pathogens can be a significant threat in the contamination of apples used to produce unpasteurized juice/cider.

The Code of Practice can be found on the Canadian Food Inspection Agency (CFIA) Web site at www.inspection.gc.ca/english/plaveg/processed/codee.shtml.

You can also contact the CFIA office at 416-954-9033.

Fertilizer Materials

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the root. Fertilizers vary in toxicity due to:

- differences in the amount of salts contained in the fertilizer
- differences in solubility of the salts in the soil
- a few specific materials or elements that are particularly toxic (for example, ammonia and boron).

The most common nitrogen fertilizers used in fruit crops are calcium ammonium nitrate, ammonium nitrate, calcium nitrate, urea, and ammonium sulphate. In most cases different sources produce equal yields. Choose your material based on availability, equipment for handling, and cost per hectare of nitrogen, plus the cost of application.

First calculate the cost per kilogram of nitrogen for various sources delivered to the farm. Depending on the rate of application, the cost per hectare can be determined. Add to this the cost of application per hectare before deciding which nitrogen source to use.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used. Table 3–7, *Fertilizer Materials — Secondary and Micronutrients,* and Table 3–8, *Fertilizer Materials — Primary Nutrients,* show the percentage of fertilizer nutrient contained in different materials.

Various fertilizer companies have available, in addition to the micronutrient sources listed in Table 3–7, premixes containing one or more micronutrients.

TABLE 3–7. Fertilizer Materials — Secondary and Micronutrients

Magnesium (Mg)	
Dolomitic limestone	6%–13% Mg
Epsom salts (Magnesium sulfate)	10.5% Mg
Sulfate of potash magnesia	11% Mg
Boron (B)	
Sodium borate	12%–21% B
Copper (Cu)	
Copper sulfate	13%–25% Cu
Copper chelates	5%–13% Cu
Manganese (Mn)	
Manganese sulfate	26%–28% Mn
Molybdenum (Mo)	
Sodium molybdate	39% Mo
Zinc (Zn)	
Zinc sulfate	36% Zn
Zinc chelates	7%–14% Zn
Zinc oxysulfate	18%–36% Zn

TABLE 3–8. Fertilizer Materials — Primary Nutrients

Nitrogen Materials	**Form**	**% Nitrogen (N)**
Ammonium nitrate	Dry	30–34
Urea	Dry	45–46
Calcium ammonium nitrate	Dry	23
Calcium nitrate	Dry	15.5
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid[1]	20
Urea-ammonium nitrate	Liquid[1]	28
Anhydrous ammonia	Liquid[1]	82
Phosphate Materials	**% Phosphate (P_2O_5)**	
Single superphosphate	20	
Triple superphosphate	44–46	
Monoammonium phosphate	48–52	
Diammonium phosphate (18-46-0)	46	
Potash Materials	**% Potash (K_2O)**	
Muriate of potash	60–62	
Sulfate of potash	50	
Sulfate of potash magnesia (11% Mg)	22	
Potassium nitrate (13-0-44)	44	

[1] Liquid under pressure

Soluble Salts In Farm Soils

High concentrations of water-soluble salts in soils can prevent or delay germination of seeds. They can either kill transplants and established plants or seriously retard their growth.

Soluble salts rarely cause a problem in crop production because Ontario soils are naturally low in soluble salts. They are not routinely measured in soil tests.

High concentrations of soluble salts can result from:

- excessive applications of fertilizers and manures
- runoff of salts applied to roads
- chemical spills on farm land.

High concentrations of soluble salts in or near a fertilizer band can seriously harm plant growth without affecting the salt concentrations in the remainder of the soil. Excessive soluble salts damage plants by restricting water uptake and pulling water out of plant tissues. Salt concentration in soil increases as water supply decreases. For this reason, plant growth is most affected by soluble salts in periods of dry weather, and in soils with low moisture holding capacity.

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water-soluble salts, the higher the conductivity. Table 3–9, *Soil Conductivity Reading Interpretation,* on page 34 interprets soil conductivity readings.

For greenhouse soils the OMAFRA-accredited soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using this method, conductivity readings up to 3.5 millisiemens/cm are acceptable.

Fertilizer Placement

Phosphorus is important for early growth. It is more available if placed near or in the root zone. For transplanted crops, use a high phosphorus starter solution.

Nitrogen fertilizers readily dissolve in soil water and move easily through soil to plant roots. Placement of nitrogen is less important than for phosphorus. Part of the nitrogen requirement is usually broadcast, injected or worked into the soil before planting, often to hasten the breakdown of the cover crop. In strawberries, a portion of the nitrogen can be side-dressed after planting, rather than applied all at once before planting. This minimizes leaching and prevents too much early vegetative growth at the expense of roots.

Too much potassium applied in a band at planting or in the transplant water can injure young transplants. This danger of fertilizer injury is greater on sands and sandy loams than on silt loam and clay loam soils. On coarse textured sand and sandy loams, broadcast and work part of the potassium fertilizer requirements into the soil before planting.

Water Quality

Water is a valuable resource. A clean and abundant supply of water is critical to the success of your farm business and the health of your family. Others, including fish and wildlife, also share water. You have a right to expect an ample supply of clean water, and it is your responsibility to make sure the water leaving your farm is abundant and clean for the next user.

Farm operations affect water quality in many ways. Soil erosion, manures, septic system effluent, milkhouse wastes, pesticides and fuels can affect surface water quality. Nutrients, manures, pesticides and fuels moving down through the soil into the groundwater can affect groundwater quality.

The greatest water quality challenges affecting farmers involve bacteria (from manures), nitrates and sediment. The following problems can be minimized using the practices listed.

Bacteria Contamination

- Contain runoff from manure storages, livestock yards and silos.

- Avoid spreading manure on frozen or snow-covered ground.

- Make sure your well is properly maintained and protected from surface contamination.

- Properly treat or store milkhouse waste water.

- Ensure your domestic septic system is working properly and is not discharging into a drainage system.

TABLE 3–9. Soil Conductivity Reading Interpretation*

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0 – 0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26 – 0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46 – 0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants
0.71 – 1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

* where conductivity is measured in a 2:1 water:soil paste for Ontario field soils, using OMAFRA-accredited procedures

Soil Erosion

- Adopt conservation tillage practices.
- Install erosion-control structures.

Nitrate Contamination

- Complete a nutrient-management plan for your farm. (See OMAFRA Factsheet *Nutrient Management Worksheet for Manure*, Order No. 98-027.)
- Avoid spreading excessive amounts of manure or fertilizer on a field.
- Where a lot of manure and forages are used, the nitrate soil test can help to determine nitrogen requirements.
- Reduce nitrogen fertilizer when the previous crop was a legume or when manure was applied. (See *Fertilizer Adjustments for Legumes Plowed Down* and *Fertilizer Adjustments Following use of Manure* on page 30.)

Pesticide Contamination

- Store pesticides properly and keep as little as possible in storage.
- Stay away from ditches and other sources of water when spraying.
- Clean up spills quickly and thoroughly.
- Be careful not to mix more pesticide than required.

Fuel Contamination

- Store fuel away from wells, ditches, etc.
- Use automatic shut-off nozzles to prevent spills.

The following Best Management Practices publications contain more information on water quality problems and solutions, soil conservation measures and nutrient and manure use.

Best Management Practices – Water Management
Best Management Practices – Field Crop Production
Best Management Practices – Nutrient Management
Best Management Practices – Pesticide Storage, Handling and Application
Best Management Practices – Water Wells

These publications are available through the Ontario Federation of Agriculture, which can be reached by tel: 416-485-3333, fax: 416-485-9027 or e-mail: genny.kinapen@ofa.on.ca.

Cover Crops and Ground Cover Management

Adaptation and Use of Cover Crops

Fruit growers can use a variety of ground cover management systems to help manage their crop growth, yield and quality while protecting their valuable soil resource. At different times during the production cycle, various cover crops or ground cover management systems may be useful. Site preparation, planting, plant establishment, fruiting (including quality enhancement) and winter hardiness can all be improved by choosing the appropriate use of ground covers.

Below is information on some of the more commonly-used cover or green manure crops.

Grasses

Grasses have fine, fibrous root systems that are well suited to holding soil in place and improving soil structure. Suitable grass species for cover crops are fast growing and relatively easy to kill — chemically, mechanically or by winter weather. Grasses do not fix any nitrogen out of the atmosphere, but they can accumulate large quantities from the soil.

Spring Cereals

Oats and barley are commonly used as green manure and cover crops. Stands seeded between mid-August to mid-September will have 20–40 cm of growth by freeze-up. The stand is generally killed by late, hard frosts. While seeding can be done outside this time frame, heat and lack of moisture in the summer may interfere with germination.

Cautions: Early seeding may result in considerable growth by freeze-up. This can form a mat of dead residue if left untilled. In the spring, this can keep soil cold and wet, interfering with spring tillage.

Ryegrass (Annual, Italian or Perennial)

Direct seed in spring or from August to mid-September, or seed with a nurse crop in spring. Ryegrass has also been broadcast into corn in late June to early July with some success. Annual ryegrass gives the most top growth in the seeding year, often heading six to eight weeks after seeding. Italian ryegrass (a biennial) does not head in the seeding year, so top growth is considerably less. However, it has the largest, densest root system of the three types. Annual and Italian ryegrasses usually suffer considerable winterkill, but part of the stand may survive. Perennial ryegrass normally survives the winter.

Cautions: Establishment and growth of ryegrasses can be poor during very hot, dry weather. It can be difficult to kill overwintering ryegrass with only cultivation or discing. The nitrogen tied up in ryegrass releases more slowly than from other cover crops.

Winter Wheat

Winter wheat can be seeded in late August through October. It can be seeded outside this time but, similar to spring cereals, weather conditions may reduce top growth. Wheat survives overwinter and begins growing in April. The stand can be killed through tillage or herbicide application. The plant shuts down earlier in fall and begins to grow later in the spring.

Cautions: Generally winter wheat does not return as much green material to the soil as rye, nor does it give the level of weed competition that rye provides.

Winter Rye

Winter rye is seeded from late August to mid-October, often following field or vegetable crops. It grows until freeze-up, and then begins growth again in March to early April (slightly earlier than winter wheat). Growth rate is very rapid during May. The stand is generally killed in late April or early May by tillage or herbicide use. Rye can produce significant root and top mass for return to the soil. A rye cover crop suppresses winter annual weeds effectively. Winter rye can be seeded later than any other crop and still survive over winter. For good ground cover and erosion protection, seed at least a month before freeze-up.

Cautions: Kill rye in the fall or early spring to avoid loss of soil moisture, and difficulties in incorporation. Rye is an excellent host for root-lesion nematode.

Sorghum Sudan

Sorghum sudan is an excellent choice for growing as a green manure crop to improve the soil. Root growth is extensive and top growth lush. A pre-plant herbicide treatment is recommended for crop establishment. Plant in mid-June, after all threat of frost is past. The crop benefits from the warm temperatures of early to mid summer. Approximately 50 kg/ha of N helps the crop achieve maximum top growth. Some varieties have nematode suppressing properties. These varieties do not have to be incorporated green for nematode suppression.

Cautions: Mow sorghum sudan before it reaches 1 m in height. This encourages tillering and ensures stalks are not woody and slow to break down. More than 1 yr of a nematode suppressing cover crop may be required to successfully reduce nematode population levels.

Forage Pearl Millet

Forage pearl millet is a warm season grass and is extremely sensitive to frost. It can produce a significant amount of top growth. This makes it a good choice as a mid summer green manure crop to improve the soil. Root growth is extensive. A preplant herbicide treatment is recommended for crop establishment. Plant in mid-June, after all threat of frost is past. The crop benefits from the warm temperatures of early to mid-summer. Approximately 50 kg/ha of N helps the crop achieve maximum top growth. Planting certain cultivars of forage pearl millet in rotation with high valued horticultural crops can reduce plant parasitic nematode soil populations below economic thresholds. Canadian Forage Pearl Millet 101 reduces nematode populations by inhibiting the ability for nematodes to reproduce in its root system. The pearl millet does not have to be incorporated green for nematode suppression.

Cautions: Mow pearl millet before it reaches 1 m in height. Do not mow shorter than 15 cm to ensure regrowth. This encourages tillering and ensures stalks are not woody and slow to break down. More than one growing season of this cover crop is necessary for nematode suppression.

Legumes

Legume cover crops can fix nitrogen from the air, supplying nitrogen to the succeeding crop as well as protecting the soil from erosion and adding organic matter. The amount of nitrogen fixed varies between species, although generally, more top growth equals more nitrogen fixed. Some legume species have aggressive tap roots that can break up subsoil compaction, but this requires more than one year's growth to happen.

Legumes are not commonly used as cover crops for fruit crop production because they provide an inconsistent and season-long release of nitrogen. Too much nitrogen at the wrong timing can interfere with fruit quality and winter hardiness of fruit crops. Legumes may flower at the same time as fruit crops and cause competition for bees and other pollinators. Legumes are also attractive to tarnished plant bugs and most are excellent hosts for nematodes. Legume cover crop species are covered in the OMAFRA Publication 811, *Agronomy Guide for Field Crops* and on the OMAFRA Web site at www.gov.on.ca/OMAFRA/english/crops/facts/cover_crops01/covercrops.htm.

Non-Legume Broadleaves

These broadleaf crops may have a role as green manure crops and in providing different plant species and root systems for soil building. They cannot fix nitrogen out of the air, but they can absorb large quantities from the soil. None of these crops are winter-hardy, so additional control measures are not normally required. Do not allow them to go to seed, as the volunteer seed can become a significant weed problem.

Buckwheat

As a cover crop, buckwheat is most commonly seeded in late June to early August. It grows very rapidly, reaching flower stage and a height of 45–75 cm in about 6 weeks. It has a relatively small fibrous root system and is completely killed by the first frost. Buckwheat provides rapid soil cover, gives good erosion protection during the growing season, smothers annual weeds and suppresses perennial ones. Moderate amounts of fresh organic matter are returned to the soil.

Cautions: Late summer seedings may be killed by an early frost before providing significant growth. Buckwheat is an excellent host for root-lesion nematode.

Oilseed Radish

Oilseed radish is commonly seeded in August or early September. It is unaffected by early frosts, can grow to a height of 50 cm in October. The plant has a thick, but short taproot, varying between carrot and turnip shaped. It is killed by severe frosts in late November or December. Oilseed radish provides a reasonably rapid soil cover and excellent erosion protection over winter. It returns moderate amounts of organic matter to the soil. For good growth, this crop must have a large amount of available nitrogen, either applied as fertilizer or residue left from a previous crop. Some oilseed radish cultivars can help to reduce plant parasitic nematode soil populations below economic thresholds.

The nematode suppressing cultivars of oilseed radish and certain mustards must be incorporated into the soil as a "green manure" crop before they will release isothiocyanate into the soil that is toxic to plant parasitic nematodes.

Cautions: Growth will be poor if soil nitrogen levels are low or if soil compaction is severe. Scattered volunteer plants usually appear in most crops planted after oilseed radish. More than 1 yr of a nematode suppressing cover crop may be required to successfully reduce nematode population levels.

Marigolds

Marigolds can be a useful cover crop for nematode suppression. Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil directly. Research has suggested nematode suppression from these cultivars can be achieved for up to 2 years. Shallowly seed marigolds in the spring once soils have warmed. Achieving a dense weed-free stand is essential to success in nematode suppression. Use of the stale seedbed technique for weed control has been successful. See Publication 75, *Guide to Weed Control,* for details.

For full effect the marigolds should be grown for a full cropping season.

Cautions: Seeding of this cover crop is difficult as the seed tends to bridge in the drill tubes. Herbicide options are limited.

For more detailed information on cover crop use and management refer to the OMAFRA Web site www.gov.on.ca/OMAFRA/english/crops/facts/cover_crops01/covercrops.htm.

Sod Covers for Orchards, Vineyards and Brambles

One of the best ways of protecting and supplying organic matter, controlling erosion and reducing late season growth, is using a cover crop. There are 2 approaches to cover crops; one temporary; the other permanent.

Temporary

A temporary cover crop is seeded late in the season. Stop cultivation by June 1 in peach orchards, July 1 in other orchards and cane fruit plantings, and by August 1 in vineyards. A cover crop such as annual Italian rye grass can then be seeded at the rate of 13–17 kg/ha. Use a soil test to determine optimum fertilizer rates or fertilize with 100 kg/ha 10-20-20 before seeding to promote growth and organic matter production. This crop is incorporated into the soil early next spring.

Permanent

For permanent sod covers, many different species of grass can be used. Choose a grass that is:

- not overly vigorous
- resistant to traffic damage in early spring and late fall
- drought resistant
- not a good habitat for voles and mice.

Short growing turf-type fescues (tall or creeping red) make excellent sods and also offer some suppression of nematodes. To aid germination, seed as shallow as possible at the rate of 20–22 kg/ha in later August or September. Prepare and fertilize the soil well, according to soil test results or with 100 kg/ha 10-20-20 before seeding. Sod mixtures containing grasses and legumes can also be used, but inclusion of forage legumes may result in the untimely release of nitrogen and concerns with pest management.

Use permanent sod covers in stone fruit orchards only where irrigation is available.

For more crop specific information see OMAFRA Factsheet *Soil Management for Orchards and Vineyards,* Order No. 92-120.

TABLE 3–10. Characteristics of Green Manure Crops and Cover Crops Grown in Ontario

Species	Normal Seeding Time	Seeding Rate kg/ha	Nitrogen Fixed	Nitrogen Uptake[3]	Overwintering characteristics	Potential Weed Problem from Volunteer Seed	Supports Nematodes[1]	
							Lesion	Root-knot
Grasses								
Ryegrass	mid-July–Aug.	13–17	no	medium	overwinters	no	—	—
Spring cereal	mid-Aug.–Sept.	100–125	no	medium	killed by heavy frost	no	+	—
Sorghum sudan	June–Aug.	50	no	med.–high	killed by frost	no	—	
Pearl millet	June–Aug.	9–10	no	med.–high	killed by frost	no	—	0
Winter wheat	Sept.–Oct.	100–125	no	med.–high	overwinters well	no	+	—
Winter rye	Sept.–Oct.	100–125	no	high	overwinters very well	no	+[2]	—
Legumes	April–June	species dependent	yes	low	most overwinter	usually not	— to +++	— to +++
Non–legume broadleaves								
Oilseed radish	mid-Aug.–early Sept.	10–14	no	high	killed by heavy frost	yes	—	—
Marigold	May–June	1.3	no	low	killed by heavy frost	usually not	—	—
Buckwheat	June–Aug.	50–60	no	low	killed by first frost	yes	+++	—

[1] Varietal differences in cover crop species may affect nematode reaction.

[2] Rye — whole season rating would be higher (+++).

[3] The potential for nitrogen uptake by individual cover crops is influenced by seeding date, stand and weather.

NEMATODE RATING CODES: (—) poor or non–host; (+) ability to host; (0) some cultivars are non–hosts

4. Pest Management

Integrated Pest Management

Integrated pest management (IPM) is an approach to pest control that uses many control strategies to maintain pest populations of insects, mites or disease organisms below an economic injury level. It does not advocate a continuous pesticide spray program to eradicate pests, but promotes the integration of cultural, biological and chemical control strategies. Adverse effects of pesticides on the environment are minimized and economic returns are maintained.

To implement an IPM program on your farm, you must have a thorough knowledge and understanding of:

- pest identification, biology and behaviour
- beneficial organisms
- monitoring techniques
- use and timing of appropriate management tools
- record keeping
- resistance management strategies.

Thresholds

An IPM program uses control guidelines, or thresholds, to indicate when to apply pesticides to prevent economic losses. Timing of control measures is critical. Guidelines for insect pests are based on an economic threshold where the cost of not applying control will be higher than applying a control. In other words, some damage to the crop is tolerated as long as this damage does not exceed the cost of the control. Guidelines for diseases, weeds, nematodes and vertebrates may be based on weather, site history, stage of crop development and field observations.

Pest Control Techniques

Chemical Controls

These include synthetic, inorganic and botanical pesticides and insect growth regulators. Chemical controls kill target pests and limit subsequent populations. They are important tools for crop protection when used in an IPM program. Understand the pest's life cycle and apply chemicals at the stage when the pest is most vulnerable. To control insects, monitor blocks closely and spray according to action thresholds established for each insect. To control disease, apply fungicides before damage occurs. The proper application of a well-timed pesticide can provide effective control of pest populations and delay resistance.

Cultural and Mechanical Pest Controls

Integrated pest management includes management practices that prevent the development of pest outbreaks and delay pesticide resistance. This is done by:

- choosing sites that are less favourable to pests
- selecting resistant cultivars
- using certified planting/nursery stock
- sanitation (removal of cull piles, dropped fruit, etc.)
- crop rotation and inter-cropping
- habitat modification (planting cover crops to promote beneficial organisms, removing weeds and alternate hosts of pests)
- pruning (removal of infected or infested plant material)
- trellising (improving air movement for better pesticide penetration)
- removal of alternate plant hosts
- nutrient management/plant health
- proper irrigation.

Biological Control

Biological control uses a pest's natural enemies to help suppress pest populations. Biological controls include predators, parasites, and pathogens, also known as "beneficials". These agents will not eliminate damage by pests, but, once established, can maintain pest populations at lower levels. They can be effective at controlling indirect pests such as aphids, leafhoppers, and mites. They are less effective at keeping populations of direct pests (those attacking the harvested product) at levels acceptable for commercial production. One of the advantages of beneficial insects is that their activities can prevent or delay the development of pesticide resistance, because they can reduce the number of sprays required to control a pest.

IPM programs attempt to take advantage of the pest control provided by beneficials by careful timing of pesticides. Understanding the life cycles of beneficials can improve the timing of spraying, cultivating, mowing and harvesting so that an adequate population of natural enemies can survive.

For additional information on predators present in fruit orchards, consult OMAFRA Publication 208, *Predatory Insects in Fruit Orchards in Southern Ontario.* For additional information on parasitoids present in fruit orchards, consult OMAFRA Publication 310, *Integrated Pest Management for Ontario Apple Orchards.*

Pathogens. Beneficial pathogens — bacteria, fungi, viruses, and nematodes — are naturally present in the crop environment. Commercially available formulations of bacteria (*Bacillus thuringiensis* or B.t.) are also available. For a list of recommended registered pest control products, see the specific commodity calendars contained in this guide.

Limitations to the success of biological controls:

- The use of broad-spectrum pesticides is often toxic to beneficials. Pyrethroids and organophosphate insecticides are often harmful to populations of predatory mites, particularly when applied late in the season.
- Introduced natural enemies may be poorly adapted to the region in which they are released.
- The crop environment may not provide shelter, overwintering sites, or alternate hosts required for successful establishment of the natural enemy.

Mating Disruption

Many adult insects emit volatile chemicals known as sex pheromones to attract members of the opposite sex. When a female moth secretes these chemicals, males use the pheromone trail or "plume", to pinpoint her location. Synthetically produced sex pheromones have been used for decades to monitor insect activity patterns. Mating disruption (MD) technology uses these same chemicals to confuse males and limit their ability to locate calling females. The release of large quantities of synthetic sex pheromone into the crop atmosphere interferes with mate location by masking the trail or pheromone plume. Mating is either delayed or prevented because the probability of males finding females is reduced. Consequently, fewer larvae are present to cause crop damage. Synthetic pheromones used in mating disruption are a form of biological control. (For additional information on synthetic pheromones and their use in pest control, see *Mating Disruption Technology (MD) for Grape Berry Moth* on page 140.

Pest Monitoring: The Critical Step

Monitoring allows you to forecast and evaluate potential pest problems. Effective monitoring identifies the pest present, estimates numbers and examines conditions favourable to pests. Monitoring allows accurate timing of pest control measures, thus reducing pesticide use. Regular monitoring will also help identify minor/secondary pest populations before they can cause significant damage.

Monitor at least once a week and preferably twice/week when the pest is most active. Good record keeping is essential. Keep a site map and record the stage of crop development, population levels of pests and beneficials, damage observed, the location of damage, weather and other environmental conditions, and the sprays and other control measures used.

Monitoring Methods

Traps. Pheromone traps are used to collect information on activity of a specific pest. Visually attractive traps (sticky boards, red spheres) are useful for indicating presence/absence and relative abundance of several flying insects. Pheromone and physical traps often catch only the adult stage of the pest, and may not provide information on the damaging larval stage.

Direct counts are used to check the number of insects or the amount of disease on a set number of plants. Tools such as tapping trays, a hand lens, and sweep nets may be used. Direct counts are obtained during regular scouting, and are an excellent supplement to trapping methods.

Weather monitoring uses data to calculate when insects will first emerge in the spring or when disease is most likely to occur.

Sampling involves collecting data to represent the entire planting being monitored. Divide large areas into sampling blocks no larger than 8–10 ha. Factors such as cultivar, training system, plant density, soil type, topography, age of the planting, and the time of day samples are taken, can effect the emergence and activity of pests. Monitor blocks of older trees and new plantings as separate units. Give extra attention to areas bordering abandoned orchards, woodlots, and fencerows because these are overwintering sites for many insect pests. Plum curculio, for example, moves into the orchard from these areas after a warm period and heavy rain in the spring. Damage to fruit in border rows indicates if and when pest control products should be applied.

Using Pheromone Traps Effectively

Pheromone traps can be used to:

- indicate the presence or absence of a pest
- show the emergence patterns of adult insects
- determine a pest's BIOFIX (a biological event marker, such as the first sustained flight)
- optimize timing of pest control products
- and assess the efficacy of a pest control program.

The proper use and servicing of traps is often critical in providing accurate information.

Place traps in the field 1–2 weeks prior to the emergence of the pest. Each pest and crop has specific recommendations for the number of traps/unit area, trap placement within the block (border versus interior) or crop canopy (height, outside/inside canopy, etc.), and the minimum distance between traps (usually 40 m or more). Mark the location of traps with flagging tape so you can find them throughout the season.

Pheromone blends are species-specific, and insects are sensitive to minute quantities of pheromones. When handling pheromone lures (or any pheromone product), wear disposable gloves to avoid cross-contamination with other products.

Check traps twice weekly. Record the number of moths caught and remove moths using a disposable scraper or small spatula. If the sticky surface appears dirty and is no longer tacky, or if there are too many moths/insects in the trap for efficient removal, it's time to replace your trap. Regular servicing is essential for maintaining trap efficiency.

When replacing traps, do not replace the lure; simply transfer it to the new trap. A new lure may be far more attractive than an old one, making it difficult to interpret trap catches. Replace lures as directed by the manufacturer. Store unused pheromone lures in the refrigerator. When trapping for several insects, use separate traps for each species. Label traps with the pest's name to ensure the correct lure is used.

How to Get Information

Fruit producers in some parts of the province have formed "Grower Funded IPM" groups who hire their own pest management scout(s). The scouts monitor each orchard or berry field for pests and report directly back to individual growers. Growers then use this collected information, along with their knowledge of IPM, to make pest management decisions.

For a list of available crop consultants providing monitoring services, contact OMAFRA's Agricultural Contact Center 1-877-424-1300, or the nearest OMAFRA Resource Centre.

For apple growers, see OMAFRA Publication 310, *Integrated Pest Management for Apple Orchards in Ontario.* Various factsheets outlining IPM for specific fruit pests are also available.

Current information is available on the OMAFRA Web site at www.gov.on.ca/omafra/english/crops/index.html. Additional information is supplied via newsletters, meetings, field monitoring demonstrations, and pest management workshops. See Appendix F, *List of Monitoring Equipment and Biological Agent Suppliers,* on page 291.

Pest Resistance to Insecticides, Fungicides, Miticides

Pests are resistant when they survive exposure to pesticides at rates that previously controlled them. Generally, resistance to a pesticide develops after repeated exposure to a specific chemical. Sprays applied to control one pest can have an impact on the status of resistance of other pests within the complex. Resistance occurs because a few naturally occurring resistant individuals survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually replace the susceptible ones. Eventually the resistant population dominates, which the pesticide cannot control.

Stable resistance means that once a pest population becomes resistant to a chemical or chemical family, it will not become susceptible again even if the chemical is discontinued for several years.

Non-stable resistance implies that a resistant population may revert back to a susceptible one once the selective pressure of a specific group of pesticides is removed.

Resistance to pesticides can develop very quickly. Do not use the same chemical repeatedly unless it is used in rotation with or in combination with other chemicals having a different mode of action. **Resistance management** reduces the risk of insects, diseases, and weeds becoming resistant to pest control products, and can dramatically increase the useful lifespan of a product.

Be aware that chemicals with the same active ingredients or the same mode of action are marketed under different brand names. As well, different chemicals may have the same mode of action. For example both Benlate and Senator act on the same site in the fungus and, therefore, have the same mechanism of control. Using Benlate after Senator is equivalent to using Benlate after Benlate, since resistance develops to both chemicals at the same time, even though only one may have been used repeatedly. The same applies for many pyrethroids.

For a list of products, their active ingredients and chemical family see Table 4–1, Table 4–2 and Table 4–3 on page 42–44.

Insecticides

Organophosphates

Resistance to this group of insecticides occurs in a number of major pests, namely tentiform leafminer on apples, oblique-banded leafroller on apples and pears, pear psylla on pears, and Oriental fruit moth on peaches and nectarines. Other orchard pests are suspected to have low levels of resistance to this group of compounds, but this is largely unconfirmed.

Over the last few years, tests have demonstrated variable levels of resistance to Imidan and Guthion in oblique-banded leafroller populations in apple, pear, raspberry, sweet cherry and peach plantings across Southern Ontario. Resistant populations have been identified in the regional municipalities of Niagara and Durham, and the counties of Essex, Kent, Northumberland and Grey.

TABLE 4–1. Insecticides Used In Fruit Crops, By Family

Chemical Family or Group	Product Name	Active ingredient
Bt Microbial	Bioprotec CAF	*Bacillus thuringiensis*
	Dipel 2XDF	*Bacillus thuringiensis*
	Foray 48BA	*Bacillus thuringiensis*
Carbamate	Carzol SP	formetanate hydrochloride
	Furadan 480F	carbofuran
	Lannate T-N-G	methomyl
	Pirimor 50DF	pirimicarb
	Sevin XLR plus	carbaryl
	Vydate	oxamyl
Chlorinated cyclodiene	Endosulfan 50W	endosulfan
	Thiodan 4EC	endosulfan
	Thiodan 50WP	endosulfan
	Thionex 50 WP	endosulfan
Chloronicotine	Admire	imidacloprid
Ecdysone disrupter	Confirm 240F	tebufenozide
Naturalyte	Success 480 SC	spinosad
Organophosphate	APM 50W Instapak	azinphosmethyl
	Cygon 480	dimethoate
	Diazinon 50W	diazinon
	Diazinon 500E	diazinon
	DZN 600 EW	diazinon
	Guthion Solupak	azinphosmethyl
	Imidan 50WP	phosmet
	Lorsban 50W	chlorpyrifos
	Malathion 25W	malathion
	Parathion 15W	parathion
	Sniper	azinphosmethyl
	Zolone Flo	phosalone
Pyrethroid	Cymbush 250 EC	cypermethrin
	Decis 5EC	deltamethrin
	Matador 120EC	cyhalothrin lambda
	Pounce	permethrin
	Ripcord 400EC	cypermethrin
Triazapentadiene	Mitac W	amitraz

TABLE 4–2. Fungicides Used In Fruit Crops, By Family

Chemical Family/Group	Product Name	Active Ingredient
Acylamine	Ridomil/ Copper*	metalaxyl†+ copper
	Ridomil Gold MZ*	metalaxyl†+ mancozeb
	Ridomil Gold 480EC	metalaxyl
Anilinopyrimidine	Vangard 75 WG	cyprodinil
Benzimidazole	Benlate T-N-G	benomyl
	Gavel 75 DF*	mancozeb + zoxamide†
	Mertect SC	thiabendazole
	Senator 75 DF	thiophanate-methyl
Chloronitrile	Bravo 500	chlorothalonil
Chlorophenyl	Botran 75W	dicloran
Dicarboximide	Ronilan EG	vinclozolin
	Rovral	iprodione
Dithiocarbamate	Dikar*	mancozeb† + karathane
	Dithane DG	mancozeb
	Dithane M45	mancozeb
	Ferbam 76 WDG	ferbam
	Gavel 75 DF*	mancozeb† + zoxamide
	Manzate 200 DF	mancozeb
	Manzate 200 WP	mancozeb
	Penncozeb 75DF	mancozeb
	Polyram DF	metiram
	Ridomil Gold MZ*	metalaxyl + mancozeb†
	Zineb 80W	zineb
Guanidine	Equal 65WP	dodine
Hydroxyanaline	Elevate 50WDG	fenhexamid
Inorganic	Copper 53W	tri-basic copper sulphate
	Kumulus DF	sulphur
	Lime sulphur	lime sulphur
	Microscopic sulphur	sulphur
	Ridomil /Copper*	Metalaxyl+ copper †
Phosphonate	Aliette	fosetyl-al
Phthalimide	Captan 80 WDG	captan
	Folpan 50 WP	folpet
	Maestro 80DF	captan
Piperazine	Funginex 190 EC	triforine
Strobilurin	Sovran	kresoxim-methyl
Triazole (DMI)	Nova 40W	myclobutanil
	Nustar	flusilazole
	Topas 250E	propiconazole

* products with two or more active ingredients
† active ingredient which puts the product in the specified group

In most areas of Ontario, there is now confirmed resistance to some organophosphate (OP) insecticides (including Imidan, Parathion, and Guthion/APM) in Oriental fruit moth (OFM) populations. The level of resistance to these OP insecticides has dropped where growers have used Lorsban and pyrethroids, as part of an IPM program. It has been shown that resistance to Guthion, Imidan, etc. does not extend to pyrethroids or Lorsban. Low levels of pyrethroid resistance have been identified and growers are advised to use these in a rotation with Lorsban for insects including the Oriental fruit moth.

Pyrethroids

The present status of spotted tentiform leafminer (STLM) and pear psylla resistance is unknown; resistance monitoring has not been conducted since the early 1990s. Previous studies have demonstrated that STLM adults have become resistant to all pyrethroids (Pounce, Decis, Cymbush and Ripcord) in many apple orchards in Ontario when exposed to repeated applications of these chemicals. Pear psylla resistance to pyrethroids has been documented in western North America and some pear orchards in the Niagara Peninsula. Resistance may occur in other parts of the province.

Surveys for resistance to OFM have been conducted at 6 locations in the Niagara region and 1 location in Essex County. Four years (1994–1998) of results indicated that resistance to pyrethroids in adult OFM were at a low frequency. Expression of resistance in larvae at these low levels has not resulted in control failures in the field when insecticides have been timed correctly to control hatching OFM larvae in peaches. The short-term resistance management strategy of using Lorsban only for first generation and the pyrethroid insecticides for the 2nd to 4th generations, has been successful. This program has stabilized or reduced the numbers of OFM moths resistant to pyrethroids.

For other tree fruit, the repeated use of pyrethroid insecticides (more than once/season) is discouraged because of the potential for further resistance development, and because pyrethroids are toxic to beneficial insects and mites.

Lannate

The status of resistance to Lannate has not been determined since the early 1990s. Several cases of STLM resistance to Lannate have been documented in Norfolk County, as well as other apple growing counties. Avoid this product where such resistance exists.

Fungicides

Benlate/Senator

Cases of resistant apple scab have been documented in most of the apple growing areas of the province. Resistance to Benlate has also been documented for brown rot on peaches and cherries, as well as for botrytis on strawberries and grapes.

Equal

Apple scab is resistant to Equal (and a previously marketed formulation known as Cyprex) in a moderate percentage of orchards in Ontario. Resistance to Equal is persistent for many years. This chemical no longer controls apple scab once resistance is established in an orchard.

Rovral

Botrytis, the causal agent of bunch rot of grapes, has developed resistance to Rovral in many vineyards after 4 years of use. Resistance is expected to develop to grey mould in strawberry fields as well. However, the resistant form of the fungus does not survive well, and declines when Rovral is not used for several years. If Rovral is only used once or twice/season, but not consecutively, resistance should remain at low levels and Rovral should remain effective.

Tests on *Monilinia fructicola*, the causal agent of brown rot on cherries, plums, peaches and nectarines, indicate there are no resistant populations in Ontario. However, there are resistant populations in New Zealand, and Australia. Therefore, do not use Rovral more than twice/season. This helps prevent resistance.

Rovral has 3 main methods of action against brown rot:

1. **Protection Activity:** the fungicide prevents infection from occurring when the residue is on the surface prior to the infection period.
2. **After Infection Activity:** the fungicide penetrates infected tissue and slows or stops fungal growth. This activity of Rovral is greatest with excellent coverage and when application is made within 48 hours from start of the wetting period.
3. **Antisporulant Activity:** the fungicide penetrates infected blossom tissue and greatly reduces, but does not totally prevent, production of brown rot spores.

Field experience shows that Rovral performs best and is most effective when applied as a protectant prior to an expected wetting/infection period. Use Rovral primarily as a protectant fungicide without relying upon its after-infection and antisporulant activities. Do not apply more than 1 application of Rovral during the bloom period, and not more than once during the preharvest period. Do not use Rovral more than twice/season, to avoid rapid development of resistance.

Ronilan

Strawberry growers note that the fungicide Ronilan is in the same chemical family as Rovral. Resistance management practices for Rovral also apply to Ronilan.

Miticides

Kelthane

European red mite (ERM) resistance to this pesticide is widespread in Ontario orchards. A 1992 survey showed that 84% of ERM populations tested in Ontario apple orchards had some level of resistance to Kelthane. Mite pressure, and the use of Kelthane, has increased in peach, nectarine and plum orchards. Many of these blocks now contain populations of European red mite populations that are either resistant or have mixed resistance to Kelthane. In grape vineyards, where Kelthane is often applied 2–3 times, it does a partial or poor job controlling European red mite. In strawberries, two-spotted spider mite populations have also demonstrated resistance to Kelthane.

Resistance to Kelthane is not stable and if it is not used for 3–5 years, the mite population gradually loses its resistance. However, if the chemical is used repeatedly (in 1 season or year-after-year) resistance returns quite quickly.

TABLE 4–3. Miticides Used On Fruit Crops, By Family

Chemical Family or Group	Product Name	Active ingredient
Avermectin	Agri-Mek 1.9 EC	abamectin
Carbamate	Carzol SP	formetanate hydrochloride
Diphenylethane	Kelthane 50W	dicofol
Pyridazinone	Pyramite	pyridaben
Tetrazine	Apollo SC	clofentezine

Apollo

Mite resistance to Apollo has now been found in a few Ontario apple orchards in southern Ontario. It is believed this resistance is not widespread. Resistance has occurred where Apollo has been applied repeatedly in one season, or applied too late in the season, causing season-long selection pressure on mite populations and poor control. Therefore, it is important to follow these recommendations. Do not use Apollo every year. Only use Apollo once in the season of use. Apply Apollo at the prescribed early timing of calyx to 2 weeks after calyx, when mite populations are synchronous and in the first summer generation egg stage. Follow a similar strategy of early season use on peach/nectarine to control mites.

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Nematodes

Plant parasitic nematodes can cause significant yield losses to many horticultural crops. The extent of loss depends on the crop, nematode species and soil population level. The most common nematodes in Ontario crops are root lesion, (*Pratylenchus*) and root knot (*Meloidogyne*). The pin (*Paratylenchus* sp.), dagger (*Xiphinema* sp.) bulb and stem, (*Ditylenchus*) and cyst (*Heterodera* sp.) nematode occasionally cause yield losses to some crops in isolated fields. The dagger nematode is mainly a virus vector on specific grape, raspberry and some apple varieties.

In Ontario, the root-lesion (*Pratylenchus penetrans*) nematode is considered the most economically important plant parasitic nematode in fruit production. Root-lesion nematodes have a wide host range including many weeds native to Ontario. Economic threshold levels from 1,000 root-lesion nematodes/kg soil for most fruit to as few as 500/kg of soil in strawberry can significantly reduce yields (Table 4–4, *Thresholds For Nematodes On Fruit Crops*). Research has shown that damage caused by root-lesion nematodes in many crops can also provide an infection site for disease causing fungi which further reduces yields.

Nematode problems are most frequently found in sandy loam and sandy soils. Always sample these soils for nematode populations before planting fruit crops.

Nematode problems are not usually found in clay or clay loam soil types. Sample these soils for nematodes before planting in replant sites, or where fruit crops have been recently grown.

TABLE 4–4. Thresholds for Nematodes on Fruit Crops

Type of nematode	Control when levels reach
Lesion nematode	1,000/kg soil (exception: 500/kg soil on strawberries)
Root knot	1,000/kg soil
Pin	5,000/kg soil
Dagger	100/kg soil
Bulb and stem	100/kg soil

Also sample clay or clay-loam soils for dagger nematode on virus-susceptible grapes, raspberry or tree fruit, and for pin nematode on rhubarb, rose and gladiolus.

Information on how to sample soil for nematodes, and where to send the samples is found in Appendix E, *Diagnostic Service*, on page 288.

Nematodes in Berry Crops

Root-lesion nematode damage on strawberries usually causes discoloration of the fine feeder roots and tiny, brown, scratch-like lesions on the young adventitious roots. These lesions merge to form large brown areas on the roots. Root-lesion nematodes are involved in the black root-rot complex and they aggravate verticillium wilt of strawberries.

Root-lesion nematode damage on raspberry roots is similar to the scratch-like lesions they cause on strawberry roots. Severely infested plants have thinner and fewer canes/crown although cane height is not usually reduced. Up to 25% of the first year canes may be killed by severe infestations of these nematodes.

Nematodes in Tree Fruits

Root-lesion nematodes can be a major cause of orchard replant failures. They can cause a decline in vigour of existing peach and cherry orchards. These nematodes kill the fine feeder roots, and cause small brown lesions on the white lateral roots. When lesions merge, the entire root system appears discoloured. Severely affected trees may not have any feeder roots, young replant trees may die. Existing trees lack uniformity.

Nematode Control

Methods to manage nematodes include:

- crop rotation with non-host crops for several years
- planting nematode suppressing cover crops
- incorporating nitrogenous soil amendments
- destroying residual crop roots
- planting resistant fruit cultivars
- controlling weeds
- soil fumigation when necessary.

Examples of nematode-suppressing cover crops:

- oilseed radish
- certain mustards
- specific sorghum x sudan-grass hybrids
- African marigolds
- Canadian Forage Pearl Millet 101.

When grown in rotation with high valued horticultural crops these cover crops can reduce plant parasitic nematode soil populations below economic thresholds. Not all cultivars reduce soil population levels of nematodes, so choose the right variety.

Cover crops suppress nematodes in different ways. Canadian Forage Pearl Millet 101 reduces nematode populations by inhibiting the ability for nematodes to reproduce in its root system. Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil directly. Nematode suppressing cultivars of oilseed radish and certain mustards must be incorporated into the soil as a "green manure" crop before they will release isothiocyanate into the soil that are toxic to the plant parasitic nematode. One or more years of nematode suppressing cover crops may be required to successfully reduce nematode soil population levels.

Exclude cover crops such as clovers and buckwheat from strawberry and orchard rotations. These are excellent hosts for root-lesion nematodes. If a cereal grain is to be used for one whole growing season, wheat or barley is the best choice. See Table 3–10, *Characteristics of Green Manure Crops and Cover Crops Grown in Ontario,* on page 38 for more information.

Nematode populations can build on many weed species. A good weed control program is essential the year before planting fruit crops. Weeds should also be controlled when nematode suppressing cover crops are grown.

Keeping land fallow the year before planting also reduces nematode numbers. A disadvantage to fallow land is increased susceptibility to soil erosion.

In orchards, choose ground covers between the rows that do not support nematodes, such as annual or perennial ryegrass.

Preplant soil fumigation is the most effective method of controlling nematode problems. It is practical when planting a new orchard or when replanting an orchard on an old tree site. Custom operators can do either broadcast fumigation or tree-row. Tree-row application (treating a 2–2.5 m strip centered on the row) is more economical.

Treat areas that harbour potential nematode problems before planting. Refer to Table 4–5, *Control of Nematodes and Related Problems in Strawberry and Raspberry Plantings in Mineral Soils* and Table 4–6, *Control of Nematodes and Related Problems in Orchards on Mineral Soils.* See OMAFRA Factsheet *Nematode Management for Ontario Orchards,* Order No. 95-061.

TABLE 4–5. Control of Nematodes and Related Problems in Strawberry and Raspberry Plantings in Mineral Soils

To Control	Material	Broadcast* (L/ha)
Nematodes only	Telone II	170
	Busan 1020	470
Verticillium & Nematodes	Telone C-17	200–380
	Vapam**	470–900
	Busan 1020	470–900

* Use higher rates for heavier soils, e.g. clay loams.

**Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

TABLE 4–6. Control of Nematodes and Related Problems in Orchards on Mineral Soils

To Control	Material	Broadcast* (L/ha)
Nematodes only	Telone II	200
	Busan 1020	470
Nematodes, Diseases	Telone C-17	280
	Busan 1020	470–900
Nematodes, Diseases, Weeds	Vapam**	470–900
	Busan 1020	470–900

* Use higher rates for heavier soils, e.g. clay loams.

**Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

CAUTION

Telone, Vapam and Busan are toxic to the applicator. Follow instructions regarding proper procedures for handling and application.

Always follow manufacturer's directions carefully concerning dosage and methods of use. A suitable respirator and protective clothing, etc., must be worn by the applicator. (See *Risks of Pesticide Use* on page 5.)

Application of Fumigants

Land preparation is critical to effective fumigant application. See OMAFRA Factsheet *Land Preparation: A Key to Successful Soil Fumigation*, Order No. 89-177. Preplant fumigation is most effective if you take the following steps.

- Fumigate in the fall when soil temperatures are above 4°C. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil.
- Remove trash and old root systems. Work the soil to a depth of 25–30 cm and obtain good seedbed condition with regard to tilth and moisture.
- Inject the fumigant about 30–40 cm deep.
- Seal the soil surface by packing or watering immediately after injecting the fumigant.
- Leave soil undisturbed until spring or, with fall planting, at least 1 week after injecting the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.
- Work the soil and aerate for about a week before planting. For fall planting, aerate the soil at least 2 weeks after working.
- Use high-quality planting stock grown preferably in fumigated soil.
- Use Italian ryegrass as an annual cover crop in cultivated orchards. Kentucky tall fescue, creeping red fescue, perennial ryegrass or annual ryegrass can be used as a permanent sod. These 3 grasses are poor hosts of the root-lesion nematode.

Single Tree Sites for Replacement Trees

Telone II: The procedure for preplant fumigation of single tree sites is the same as that described above, except that the fumigant is injected with a hand applicator (Fumigun) on 20 × 20 cm centres over a 2.5 × 2.5 m area. The rate of Telone/injection point is 0.8 mL. Fumiguns can usually be rented from custom applicators or pesticide dealers. Operators must wear protective equipment and clothing.

Vapam: Mix Vapam with water. Prepare the site and apply as a drench in the fall to individual replacement tree locations. For each replacement location, construct a circular basin in the soil — approximately 2 m across. While wearing protective equipment and clothing, add 0.3 L of Vapam to 90 L of water in a drum or tank. When solution is thoroughly agitated or mixed, apply it to each basin. This volume of solution is necessary for adequate penetration of the proposed root zone.

Busan 1020: After removing dead or diseased trees and as much of the root system as possible, make a shallow basin over the planting site. Add Busan 1020 to the stream of water while filling the basin. Use 1 L Busan 1020/10 m^2 in sufficient water (depending on soil type) to penetrate at least 2 m. For control of oak root fungus, use a basin at least 6 × 6 m. Increase dosage to 2 L Busan 1020/10 m^2 in sufficient water to penetrate to the depth of root system. If water is tanked to the planting site, add Busan 1020 to the water and mix before filling basin.

VYDATE L — Post-plant Treatment

CAUTION

Vydate L is very toxic to humans. See references to *Risks of Pesticide Use* on page 5 and *Cholinesterase Blood Tests* on page 6. Follow instructions closely regarding proper procedures for handling and application.

Non-Bearing Apples

Post-plant treatment of non-bearing apple trees for reduction of root-lesion nematode numbers can be achieved with oxamyl (Vydate L = 240 g active oxamyl/L). Apply a liquid-soil drench soon after planting. The liquid-soil drench is mixed at 1.25 L Vydate/1,000 L water and applied at 3.5–10 L of the solution/tree, in a circle around the base of the tree to cover the root zone. Do not use if air temperature is below 7°C, as Vydate is less effective at low temperatures. When leaves have expanded, apply a foliar application and repeat in 3–4 weeks. (Do not allow spray to drift on any trees in bloom). The foliar spray mix is 4.1–8.2 L Vydate/1,000 L water applied at not over 9.3 L Vydate/ha in any 1 application. Sample the soil for nematodes in early September of the planting year to check on the need for further treatment.

For established non-bearing apple trees, apply the liquid soil drench early in April when buds are swelling. Apply a foliar spray before tight cluster and after petal fall.

Root absorption of Vydate occurs during periods of rapid shoot growth (early spring). Foliar absorption occurs best in young, rapidly expanding foliage. See the manufacturer's label for further details, precautions, and methods of application.

No soil-borne disease control should be expected with Vydate L. Post-plant treatments for nematode control are less effective than preplant soil fumigation. Post-bloom foliar sprays interfere with insect predators and are not recommended in orchards using integrated pest management.

Raspberries

For reduction in the number of root-lesion nematodes, apply Vydate L as a liquid soil drench over the root zone.

Apply 1 application of Vydate L at 9.35 L/ha of treated soil area in the fall as a soil drench over roots. If you are treating a 1.5 m wide strip, use 1.4 L of Vydate in 360 L of water on 1,000 m of row. Vydate is absorbed only by raspberry roots that are actively growing. Late application on dormant plants or when air temperature is below 7°C may not give satisfactory results. Do not apply more than once during a 12-month period.

Vydate is highly toxic to bees. Do not apply during the pink or bloom period.

Wildlife Control

Bird Damage and its Prevention in Fruit Crops

Every year birds destroy large quantities of fruit in Ontario. Sweet cherries, grapes, and blueberries are the crops most subject to attack, but other fruit crops may also be damaged. Losses estimated between 0 and 100% for fruit crops are common, although the extent of fruit damage varies greatly among cultivars, location, and seasons. Pecking and puncturing damage is usually greater than actual losses from fruit consumed, and often causes secondary problems with rot.

Controlling bird damage

Start controls early and infrequently, 10 days prior to colouring of the crop when it becomes attractive to the birds. This could be as early as one month prior to harvest for some fruit cultivars. An integrated approach is the best method of bird control. Use several control methods to provide a longer lasting effect.

Location

Where you plant your commercial fruit crops can be an important factor in controlling birds. Cherry orchards and vineyards planted near a wooded area are particularly susceptible to damage, as birds find shelter and nesting sites close by.

Physical Protection

The only completely foolproof control method is to cover the crops with netting. This method may be economically feasible for some cultivars of grapes, cherries and highbush blueberries.

Shooting

Destruction of starlings and grackles is still a very practical control method. Normally shooting does not reduce the bird population, but it does frighten them out of the orchard. Law protects robins and Northern orioles, but special permits may be obtained to kill them if you can show they are causing damage.

For a permit contact the Enforcement Co-ordinator, Canadian Wildlife Service, Environment Canada, 905-336-6410.

Shells are also available with delayed explosions and/or sustained whistles that disorient and frighten the birds.

Propane-Fired Bird Scaring Cannons

Cannons are one of the most commonly used bird-scaring devices. These devices cause birds to flee by producing loud, unexpected gunshot-like sounds, usually at random intervals. Regular movement of the devices to different locations in the orchard or vineyard is very important. Birds quickly adjust their feeding habits if the scaring device is left in the same location throughout the harvest season.

A major drawback of these devices is the disruption to your neighbours' quality of life. Growers must recognize this fact and adjust the use of this equipment to cause the least discomfort to those around them.

Electronic Sound Devices

This equipment sends out electronic sounds that imitate distress or predator calls of different bird species, or other types of sounds. Although they produce a loud sound, it is usually less objectionable to neighbours than the propane-fired cannons.

Chemical Controls

There are currently no chemicals registered for use in Ontario to control birds in fruit crops. It is illegal to use unregistered chemicals on any food crops.

Visual Deterrents

Visual deterrents include: aluminum foil hung in trees, model hawks and other birds of prey, strips of yellow plastic hung across vineyards, vibrating plastic strips, scarecrows, mirrors, kites, and scare-eye balloons. Visual deterrents move with the wind, producing noise and making reflections.

Falconry

Trained falcons and hawks have been used successfully for many years at airports. Experienced falconers are needed to fly the birds. Availability, cost and time are major drawbacks for fruit growers.

Regardless of the bird control method used, all local, provincial and federal laws governing the killing of birds, or the use of sound-scaring devices must be followed.

Rodent and Deer Control in Orchards

For more information on all aspects of deer and rodent control, see OMAFRA Factsheet, *Rodent and Deer Control in Orchards*, Order No. 98-023 and Publication 10, *Deer Control Practices in Agriculture.*

Control of rodents and deer is most effective when it is part of a season-long management strategy. This includes good sanitation, cultural and chemical control methods.

Bait for Mouse and Vole Control in Orchards

Zinc phosphide-treated baits — Several products are available. Generally the rates of application are between 4.5–9 kg/ha, depending on the severity of infestation. Pellets are normally broadcast after apple drops are picked up. Bait stations will prevent non-target mammals from getting at the bait. If further mouse activity is detected, repeat the treatment when rain is not expected.

Diphacinone (Ramik Brown) — 22 kg/ha in 2 applications of 11 kg each. Applications can be made 20–40 days apart.

Chlorophacinone (Rozol, Groundforce) — Apply 11–11.25 kg/ha and repeat in 20–60 days where infestation is high.

Wrapping Young Trees

Wrap sacking about the top and the trunk above the mouse guard to protect young trees from rabbits. Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when the snow is deep.

Repellents

Taste repellents: Rabbits do not like to feed on the trunks of young trees if the trees have been treated with thiram. There are a number of commercial mixtures available, some of which mix white latex paint with thiram. Be sure to treat the tree as high as rabbits can reach when standing on deep snow.

For more information refer to *Control of Southwest Injury on Fruit Trees* on page 50.

Deer Removal Permit Program

The MNR area supervisor or enforcement supervisor issues permits to farmers or their agents in order to kill white-tail deer in defense of property under Section 2.1 of the *Game and Fish Act.*

You must have a permit to shoot deer in defense of property. Contact the local Ministry of Natural Resources (MNR) office for an evaluation and action plan. Action depends on the severity of damage, the level of previous control attempts and a reasonable expectation of controlling the problem deer.

Before a deer removal permit is issued, the following conditions must be satisfied.

- Deer damage is evaluated as economically significant by the evaluator. A written report must be filed reflecting the extent (percent of crop) and associated dollar value.
- The farmer permits licensed deer hunters on the property during open season (if any); the farmer has made reasonable attempts to control deer using deterrents or by modifying farm management practices. This should be documented and kept with the deer removal permit file.
- Appropriate arrangements for the disposition of the carcass have been established.

Repairing Damage by Mice and Rabbits

Carry out regular inspection throughout the winter to check for injury. Mice often work just below the surface of the snow or in the litter. If a tree has been wholly or partially girdled, cover the wound with grafting compound or wound dressing promptly or before drying out occurs.

Before the buds swell in the early spring, secure scions that are long enough to bridge the wound. See OMAFRA Factsheet *Repair Grafting*, Order No. 98-003. Store scions in damp sand or sawdust in a cool place or preferably under refrigerated conditions. If the wound extends for more than one quarter of the circumference of the trunk, bridge graft in the manner described in *Repair Grafting*. Graft when the bark slips readily from the wood (about bloom). Repair grafting is not practical on trees with a diameter less than 10 cm. Instead, replace small trees.

Control of Southwest Injury on Fruit Trees

Southwest injury (winter sunscald) occurs during the winter and is especially severe when cold, sunny days are followed by cold, clear nights. This phenomenon can occur in apple, peach, pear, cherry, plum and apricot orchards. Injuries are usually confined to the south and southwest sides of the trunks and main scaffold branches. On sunny days these tissues become considerably warmer than the surrounding air and at night they cool rapidly. Under these conditions, freezing of the bark may occur. Freezing injury usually affects large portions of the bark tissue that become brown and eventually slough off as healing occurs beneath.

In stone fruit orchards, these injuries provide ideal sites for infection by the peach canker or other canker diseases. The combined effect of southwest injury and peach canker greatly reduces the productive life of affected trees.

Painting the trunk, crotches, and lower parts of main scaffold branches with exterior white latex paint can minimize southwest injury. The white paint reduces the damage by reflecting direct sunlight on exposed tissue, which helps to prevent rapid thawing on cold days when air temperatures are below freezing.

Do not use oil-based paints or latex paints that contain some oil. These products contain toxic materials that may injure or kill fruit trees.

October is the best time to apply the paint. Best results are obtained when trees are painted on days when the temperature is above 10°C and conditions favour rapid drying. Apply the paint by brush or by spray. When spraying, use 1–2 L of water/4.5 L of paint, depending on the thickness of the paint and the air pressure available. On young trees, paint the whole trunk, but on older trees only the south and southwest sides of the trees require painting. The whiter the bark after painting, the greater the protection. Better quality paints are more durable.

On young trees, injury from rodents may be a greater problem than southwest injury. To obtain protection from both problems, use commercially available thiram–latex mixtures which reflect sunlight and act as a taste repellent for rodents.

Do not use the thiram-latex mixture if you plan on using a fall Bordeaux spray program. The thiram reacts with the Bordeaux spray, changing the colour of the paint from white to brown, and reducing its effectiveness as a heat reflector. The Bordeaux spray does not affect trees painted with latex only and can be used when thiram is excluded from the mixture.

Use of Copper Products on Fruit Crops

Chemical Characteristics of Copper Fungicides

Copper mixtures have long been recognized as having fungicidal properties. Historically, Bordeaux mixture was the main copper fungicide. It was made by mixing bluestone (a raw form of copper sulfate) and hydrated lime. The free copper ions provide most of the activity that copper mixtures have on fungal and bacterial diseases. This free copper can also be toxic to plants, causing burning of leaves, and burning or scarring of fruit. Bordeaux mixtures are considered unsafe after "1/4 inch green" on most fruit crops.

The copper product known as "Noranda superfine bluestone" is no longer registered for use on agricultural crops for the purpose of crop protection.

"Fixed copper" collectively describes a group of copper formulations containing complex copper sulfates, copper oxychlorides, and copper oxides. Fixed copper compounds are easier to handle than Bordeaux, are equal in effectiveness to Bordeaux — except they do not adhere or persist as well — and are generally less phytotoxic and less corrosive than Bordeaux. These new copper formulations have a small particle size and have added materials to improve spreading and sticking qualities. Check the product label for use patterns and timings for each crop.

Procedures To Tank-Mix Copper Formulations and Lime

Some fixed copper labels suggest mixing the copper with lime. If you have problems mixing fixed coppers with lime, consider the following instructions:

1. Start water flowing into the spray tank.

2. When the tank is about 1/3rd full and the mechanical agitator is operating, start washing the powdered copper product into the tank through a screen with water from the supply hose. Use a wooden spoon to help work the copper product through the screen. The screen prevents large granules of copper (especially if opened product gets wet, then dries) from getting into the tank. Premixing copper product with hot water also helps the product dissolve.

3. Put all of the copper in the tank by the time the tank is 2/3rd full. Then wash the lime (use hydrated or builder's lime) through the screen into the copper solution in the tank. Use the water from the supply hose. Use lots of water to dilute the lime as much as possible before it meets the copper solution. Presoaking the lime before adding to the tank may be preferable to washing powdered lime directly through the screen into the tank.

4. Keep the agitator running continuously and apply the copper mixture immediately. Do not allow the mixture to settle out.

Registration Status and Availability of Copper Fungicide Products

It is important to use only copper products that have a federal label with a PCP number. The PCP number indicates a product that has been approved as a crop protection product for application on agricultural crops. Presently, there are 5 copper products that have PCP numbers and possess a federal registration. For a summary of labelled products and crop uses consult Table 4–7, *Copper Products for Use on Fruit Crops in Ontario.*

TABLE 4–7. Copper Products for Use on Fruit Crops in Ontario*

Category	Registered Copper Products				
Product Name	Clean Crop Copper 53W	Griffin Basicop	Guardsman copper oxy-chloride 50	Clean Crop Copper Spray	Triangular Brand Copper Sulfate
PCP Registration No.	9934	19003	13245	19146	24034
Ontario Classification	Schedule 2	Schedule 3	Schedule 2	Schedule 3	Schedule 3
Active Ingredient	copper from tribasic copper sulfate 53%	copper in basic copper sulfate 53% by weight	copper from copper oxychloride 50%	copper from copper oxychloride 50%	cupric sulphate pentahydrate (metallic copper 25.2%)
APPLES					
registration status	✔	✔	✘	✔	✔
rate of formulated copper[1]	1 kg	1 kg		4kg	2 kg
rate of hydrated lime	6 kg	6 kg		—	6 kg
APRICOTS					
registration status	✘	✘	✘	✘	✘
rate of formulated copper[1]					
rate of hydrated lime					
BLACKBERRIES					
registration status	✘	✘	✘	✘	✘
rate of formulated copper[1]					
rate of hydrated lime					
BLUEBERRIES					
registration status	✘	✘	✔	✔	✘
rate of formulated copper[1]			2–4 kg	2–4 kg	
rate of hydrated lime			no lime required	no lime required	
CURRANTS					
registration status	✔	✔	✘	✘	✘
rate of formulated copper[1]	3–5 kg	3–5.5 kg			
rate of hydrated lime	4 kg	4 kg			
FILBERTS HAZELNUTS					
registration status	✘	✘	✔	✔	✘
rate of formulated copper[1]			3–9 kg/ha	3–9 kg/ha	
rate of hydrated lime			no lime required	no lime required	
GOOSEBERRIES					
registration status	✔	✔	✘	✘	✘
rate of formulated copper[1]	3–5 kg	3–5.5 kg			
rate of hydrated lime	4 kg	4 kg			
GRAPES					
registration status	✔	✔	✔	✔	✘
rate of formulated copper[1]	3 kg[2]	3 kg	3 kg	3 kg	
rate of hydrated lime	6 kg	6 kg	6 kg	6 kg	
PEACHES/NECTARINES					
registration status	✔	✔	✘	✔	✘
rate of formulated copper[1]	4 kg	4 kg		2 kg	
rate of hydrated lime	no lime required	no lime required		no lime required	

[1] rate is expressed kg/1,000 L of water unless otherwise stated. To calculate rate/ha see Table 2–1, *Water Volume Guidelines Based on Tree Row Volume*, on page 19 and Chapter 2, *Pesticide Application*. Also check label for maximum rate/ha.

[2] Do not use on French hybrids or vinifera varieties.

* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 2001.

✔ registered in Ontario

✘ not registered

TABLE 4–7. Copper Products for Use on Fruit Crops in Ontario* (Continued)

Category	Registered Copper Products				
Product Name	Clean Crop Copper 53W	Griffin Basicop	Guardsman copper oxy-chloride 50	Clean Crop Copper Spray	Triangular Brand Copper Sulfate
PCP Registration No.	9934	19003	13245	19146	24034
Ontario Classification	Schedule 2	Schedule 3	Schedule 2	Schedule 3	Schedule 3
Active Ingredient	copper from tribasic copper sulfate 53%	copper in basic copper sulfate 53% by weight	copper from copper oxychloride 50%	copper from copper oxychloride 50%	cupric sulphate pentahydrate (metallic copper 25.2%)
PEARS					
registration status	✔	✔	✘	✘	✔
rate of formulated copper[1]	1 kg	1 kg			2 kg
rate of hydrated lime	6 kg	6 kg			6 kg
PLUMS					
registration status	✘	✘	✘	✘	✘
rate of formulated copper[1]					
rate of hydrated lime					
RASPBERRIES					
registration status	✔	✔	✔	✔	✘
rate of formulated copper	4 kg/ha	4 kg/ha	2.5–3.0 kg/ha	2.5 kg/ha	
rate of hydrated lime	no lime required	no lime required	no lime required	no lime required	
SOUR CHERRIES					
registration status	✔	✔	✔	✔	✘
rate of formulated copper[1]	2 kg	2 kg	2 kg	2 kg	
rate of hydrated lime	4 kg	no lime required	4 kg	4 kg	
SWEET CHERRIES					
registration status	✘	✘	✘	✘	✘
rate of formulated copper[1]					
rate of hydrated lime					
STRAWBERRIES					
registration status	✔	✔	✘	✘	✘
rate of formulated copper	2.5–3.8 kg/ha	2.3–3.8 kg/ha			
rate of hydrated lime	no lime required	no lime required			
WALNUTS					
registration status	✘	✘	✘	✔	✘
rate of formulated copper				4 kg/ha	
rate of hydrated lime				no lime required	

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[1] rate is expressed kg/1,000 L of water unless otherwise stated. To calculate rate/ha see Table 2–1, *Water Volume Guidelines Based on Tree Row Volume,* on page 19 and Chapter 2, *Pesticide Application.* Also check label for maximum rate/ha.

[2] Do not use on French hybrids or vinifera varieties.

* List of copper products with federal registration and classified for sale and use in Ontario, as of November, 2001.

✔ registered in Ontario

✘ not registered

5. Food Safety

On-Farm Food Safety for Fruit and Vegetable Growers

Food safety hazards include biological, physical or chemical substances that can cause produce to become an unacceptable health risk to consumers.

- **Biological hazards:** Micro-organisms such as bacteria, viruses, parasites, moulds
- **Physical hazards:** Foreign objects (i.e. wood, plastic, glass) from the environment or equipment
- **Chemical hazards:** Pesticide or other contaminants

Contamination of produce at the farm can occur directly or indirectly. Produce may be directly contaminated by food safety hazards at the farm or indirectly through contaminated soil, water, etc. Growers can minimize the risk of contamination by:

- being aware of the hazards
- identifying potential sources of contamination and using best management practices to minimize the risks on your farm
- periodically reviewing all farm practices with food safety in mind.

Many growers use the good agricultural practices presented below; however, with little documentation existing, it is difficult to verify. Good record keeping of on-farm practices as they pertain to food safety is useful in today's marketplace.

Preventing Biological Hazards on Fruit and Vegetables

Sources of Contamination

- Untreated or raw manure used for fertilizing.
- Produce that comes in contact with contaminated soil, water or feces from animals (e.g. rodents, birds, domestic animals and wildlife).
- Containers and/or equipment not cleaned adequately.
- Handling of produce by infectious workers

Good Agricultural Practices

- Know the history of your land. Fields where livestock or wild animals have grazed, or where biosolids or sludge have been applied, are more likely to have pathogenic bacteria.
- Take measures to discourage roosting of birds above packing, handling and storage areas.
- Maximize the period between when manure is applied and when the crop is harvested. Incorporate manure into the soil before planting. Do not apply manure after planting where direct or indirect contact may occur with the edible part of the crop. (See *Food Safety Concerns with Manure Application and Timing* on page 31.)
- Use compost or aged manure to reduce microbe levels. Composting is more effective than aging.
- Do not use manure for side-dressing.
- If stockpiling animal manure on the farm, place the pile in a location to avoid both contamination from wind drift to adjacent crops or harvested produce and potential runoff into water sources.
- Clean and sanitize farm implements to prevent cross-contamination.
- Make sure water quality is appropriate for the use. Use potable water for hand washing, cleaning surfaces etc.
- Consider testing irrigation water for bacterial levels. The type of water source and what it will be used for determines the frequency of tests taken per year. Ditch or surface water requires more testing than well or municipal water.
- Depending on water source, consider installing drip irrigation rather than overhead sprinklers to reduce

the risk of contamination, especially for produce generally eaten uncooked.

- Cool fruits and vegetables quickly to maintain quality. Keep coolers/storage areas clean and ensure cooling equipment is maintained and sanitized.
- Ensure toilets and hand-washing stations are stocked and cleaned regularly, and are readily accessible to staff and visitors.
- Teach workers the importance of personal hygiene practices and establish guidelines.

Preventing Physical Hazards on Fruits and Vegetables

Sources of Contamination

- Dirty harvesting and packing equipment.
- Broken lights or bottles.
- Damaged containers or pallets.
- Inadequate cleaning after repairs or maintenance.
- Equipment parts or metal staples from packing equipment.
- Improper grading or inspection of finished product.
- Careless or untrained staff.
- Inappropriate clothing.

Good Agricultural Practices

- Construct and maintain structures to minimize risk of contamination.
- Maintain equipment regularly, and ensure equipment is cleaned and ready for use after repairs or maintenance.
- Teach workers about physical hazards and ensure they follow all existing guidelines.

Preventing Chemical Hazards of Fruits and Vegetables

Sources of Contamination

- Pesticide residue in soil from previous use.
- Pesticide not registered/approved.
- Incorrect mixing — concentration higher than recommended rate.
- Days-to-harvest period not followed.
- Dumping, accidental spillage or seepage of pesticide into soil or water source.
- Equipment either not, or incorrectly, calibrated.
- Equipment not cleaned after use.
- Pesticide residue in picking bin or crate.

Good Agricultural Practices

- Know the history of the land. Chemicals, biosolids or sludge may have been used previously and possible residues left behind.
- Use pesticides as directed on the label. Ensure they are safely stored and labeled in a secure area.
- Participate in the Grower Pesticide Safety program. Ensure employees who handle pesticides are also certified.
- Consider doing a yearly chemical residue test of product to verify that chemicals are applied correctly.
- Calibrate your sprayer regularly.

References

Ontario Ministry of Agriculture, Food and Rural Affairs:
www.gov.on.ca/OMAFRA

Canadian Water Quality Guidelines for Agricultural Water:
www2.ec.gc.ca/ceqg-rcqe/agrtbl_e.doc

Canadian Hort Council Guidelines:
www.hortcouncil.ca/offs.htm

Canadian Food Inspection Agency:
Code of Practice for Minimally Processed Ready-to-eat Vegetables:
www.inspection.gc.ca/english/plaveg/fresh/read-eat_e.shtml

Code of Practice for Production and Distribution of Unpasteurized Apple and Other Fruit Juice/Cider in Canada:
www.inspection.gc.ca/english/plaveg/processed/codee.shtml

Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables:
www.foodsafety.gov/~dms/prodguid.html

Good Agricultural Practices for Fresh Fruits and Vegetables:
www.hort.cornell.edu/extension/commercial/vegetables/issues/foodsafe/index.html

National Food Safety Database:
www.foodsafety.gov

Food Institute of Canada:
http://foodnet.fic.ca

6. Pollination and Bee Poisoning Prevention

Pollination Requirements for Fruit Crops

Most fruit crops benefit from or require insect pollination.

Apples

Apple cultivars grown in Ontario do not generally set fruit with their own pollen. Pollination with pollen from more than 1 cultivar normally results in larger fruit compared to fruit grown from a single source of pollen. A bloom requires 8–24 visits by pollinators. A well-designed orchard reduces the number of bee visits required.

Good pollen movement is necessary for fruit with high seed count. Good pollen movement in a higher density planting is generally limited to 3–4 rows across the orchard. The distance pollen travels down the row is limited to a few trees. For this reason, 2 or more compatible cultivars must be planted together in the orchard to allow for cross-pollination and fruitfulness. Varying the placement of beehives does not normally have a significant influence on pollen dispersal distances within the apple orchard.

Apricots

Most varieties are self-fruitful and may be planted in solid blocks. Because apricots bloom early when the weather is unreliable, provide honeybees to help with pollen transfer.

Blueberries

Blueberries are self-fruitful and may be planted in solid blocks. However, cross-pollination of cultivated blueberries can give larger berries, higher yields and somewhat earlier ripening. It is advisable to plant more than 1 blueberry variety. Honeybees help with pollination.

Sour Cherries

Sour cherries are self-fruitful and do not require pollenizer cultivars for a commercial crop. For maximum production of sour cherries, use honeybees at a rate of 2 strong hives per hectare. Sour cherries and sweet cherries are different species, and will not pollinate each other.

Sweet Cherries

Sweet cherries are not pollinated by wind; the honeybee — use 2 hives per hectare — is the only effective pollinating insect reported. Many sweet cherry cultivars are self-unfruitful and must not be planted in solid blocks. Certain groups of cultivars will not pollinate each other. Careful attention to planting arrangement of sweet cherries is required. Recent sweet cherry cultivar introductions from the Vineland breeding program are self-compatible.

Currants and Gooseberries

These are self-fruitful, but insects assist in pollen transfer. Honeybees can increase crop yield.

Grapes

All commercial varieties of grapes are self-fruitful and are pollinated by wind. It is not necessary to provide honeybees for pollination.

Peaches and Nectarines

All commercial varieties grown in Ontario are self-fruitful and may be planted in solid blocks. Honeybees readily work peach blossoms and frequently cause a heavy set, resulting in extra thinning costs. For this reason, do not put beehives in peach orchards.

Pears

All varieties in Ontario are self-unfruitful. Mixed plantings are necessary. Insects are required for cross-pollination. Honeybees do not find pear blossoms as attractive as most other fruit. Careful timing of the introduction of honeybees to orchards is necessary. Place up to 8 strong hives per hectare when the orchard is about 25% in bloom. Use pollen inserts to help overcome pollination problems.

Plums

Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.

Raspberries and Blackberries

Raspberries are self-fruitful. Their bloom is very attractive to bees.

Strawberries

Strawberries are self-fruitful, and are pollinated by gravity, wind and insect transfer. Pollination by honeybees or other insect pollinators may improve berry size and shape.

Tree Nut Crops

These rely on cross pollination achieved mainly by wind action.

Using Honeybees Effectively

The primary domesticated insect pollinator of cultivated crops is the honeybee. Many growers facilitate the pollination process by arranging to have beekeepers move honeybee colonies into their crops during the blooming period. The following information will help you use honeybees more efficiently.

- Obtain honeybees from a reliable beekeeper able to supply strong, healthy colonies. Weak colonies are of little value for early spring pollination when cool weather is often encountered.

- Two to 3 colonies of honeybees per hectare provide satisfactory pollination. Stocking rates vary depending on the type of fruit, the variety and the planting density. In young orchards fewer honeybee colonies may be required because there are generally fewer blossoms to pollinate. On the other hand, for early blooming fruit crops such as apricots, cherries and plums, you are better off to use more honeybee colonies than the recommended stocking rates indicate. This precaution should compensate for the negative effect of cold weather, which often occurs during the pollination period of these crops.

- A pollen insert is a device that forces bees leaving the hive to crawl through a shallow tray containing pollen from the desired pollenizer. Pollen adheres to the legs and body of each foraging bee to enable it to cross-pollinate the blossoms it visits.

- When using a pollen insert, place hives in the crop after blossoms have partially opened (earlier for sweet cherries, later for pears). This encourages more bees to work the fruit blossoms in the immediate surroundings, rather than foraging elsewhere. This recommendation is extremely important to ensure the effective use of pollen inserts. Have 5 colonies per hectare when using pollen inserts.

- Weather is often cool during the pollination period for early-blooming fruit crops. To encourage maximum honeybee flight during cool weather, protect the colonies from cold spring winds. Place the colonies in larger groupings in sunny, sheltered locations. Where there is no natural windbreak, erect a temporary wind shelter using, for example, bales of straw. Place the colonies so that the morning sunshine strikes the hive entrances.

- Provide water to colonies during bloom periods that are exceptionally dry. Bees will abandon pollen collection in favour of securing water for the colony. A shallow tub of water with floating sticks allows bees to land without drowning.

- Honeybees favour apple pollen over dandelion pollen. Apple pollen provides a higher quality protein that bees require to feed colony brood. Although bees will forage on dandelion as a protein source, the vast majority will move to apple pollen quickly when it becomes available. Apple growers do not need to be concerned about dandelion bloom drawing bees away from apple bloom. A rigorous program of mowing dandelion bloom in orchards is no longer recommended for Ontario apple growers.

For information contact the OMAFRA apiary specialist at 1-888-466-2372 ext. 63595 or by e-mail at dmcrory@omafra.gov.on.ca.

Recommended Publications

For more information on pollination requirements of fruit crops, refer to OMAFRA Publication 430, *Fruit Cultivars, A Guide for Commercial Growers.*

Bee Poisoning

Bees are essential for the pollination of most tree and small fruits. Insecticides, many of which kill bees, are required for insect control. With careful management, you can obtain both pollination and insect control. You can protect the bees by following these suggestions.

- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Read label for guidelines.
- Time of treatment is important. In general, daytime treatments when bees are foraging in the field are most hazardous. Insecticide applications in the evening are the safest. Early morning is the next best time.
- Remove honeybee colonies as soon as pollination is complete and before any postbloom insecticides are applied.
- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to the bees.
- Honeybees frequently are poisoned by visiting cover crops, such as dandelions or clovers, that are in bloom in the orchard. Clipping or beating down such crops prior to spraying will help safeguard the bees.

The following groups found in Table 6–1, *Relative Toxicity of Pesticides to Honeybees,* (chemicals used with fruit crops) show the relative toxicity of pesticides to honeybees as determined by laboratory and field tests.

For more detailed information on the toxicity of specific pesticides to honeybees refer to the pesticide label.

TABLE 6–1. Relative Toxicity Of Pesticides To Honeybees

Group I — Pesticides Highly Toxic to Bees	Group II — Pesticides Moderately Toxic to Bees	Group III — Pesticides Relatively Non-Toxic to Bees
Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter:	*These can be used around bees if dosage, timing, and method of application are correct, but do not apply them directly on bees, in the field or at the colonies:*	
ADMIRE	CARZOL SP	ALIETTE WDG
AGRI-MEK 1.9EC	DIKAR	APOLLO SC
APM 50W INSTAPAK	ENDOSULFAN 50W	BENLATE T-N-G
CYGON 480	LANNATE T-N-G	BIOPROTEC CAF
CYMBUSH 250 EC	METASYSTOX R 240EC	BOTRAN 75W
DECIS 5EC	NUSTAR	BRAVO 500
DIAZINON 500 E	PIRIMOR 50DF	CAPTAN 80 WDG
DIAZINON 50W	THIODAN 4EC	CONFIRM 240F
DZN 600 WDG	THIODAN 50WP	COPPER 53W
FURADAN 480F	ZOLONE	DIPEL 2X DF
GUTHION SOLUPAK		DITHANE DG
IMIDAN 50 WP		DITHANE M45
LORSBAN 4E		ELEVATE 50 WDG
MALATHION 25W		EQUAL 65 WP
MATADOR 120EC		FERBAM 76 WDG
PARATHION 15W		FOLPAN 50WP
POUNCE		FORAY 48BA
PYRAMITE		FUNGINEX 190 EC
RIPCORD 400EC		GAVEL 75 DF
SEVIN XLR PLUS		KELTHANE 50W
SUCCESS 480 SC		KUMULUS DF
SNIPER		MANZATE 200 DF
SNIPER 240 E		MANZATE 200 WP
VYDATE		MAESTRO 80 DF
		MITAC W
		NOVA 40W
		PENNCOZEB 75DF
		POLYRAM DF
		RIDOMIL GOLD 480 EC
		RIDOMIL GOLD MZ
		RIDOMIL COPPER
		RONILAN EG
		ROVRAL
		SENATOR 70WP
		STREPTOMYCIN 17
		TOPAS 250E
		VANGARD 75EG
		ZINEB 80W

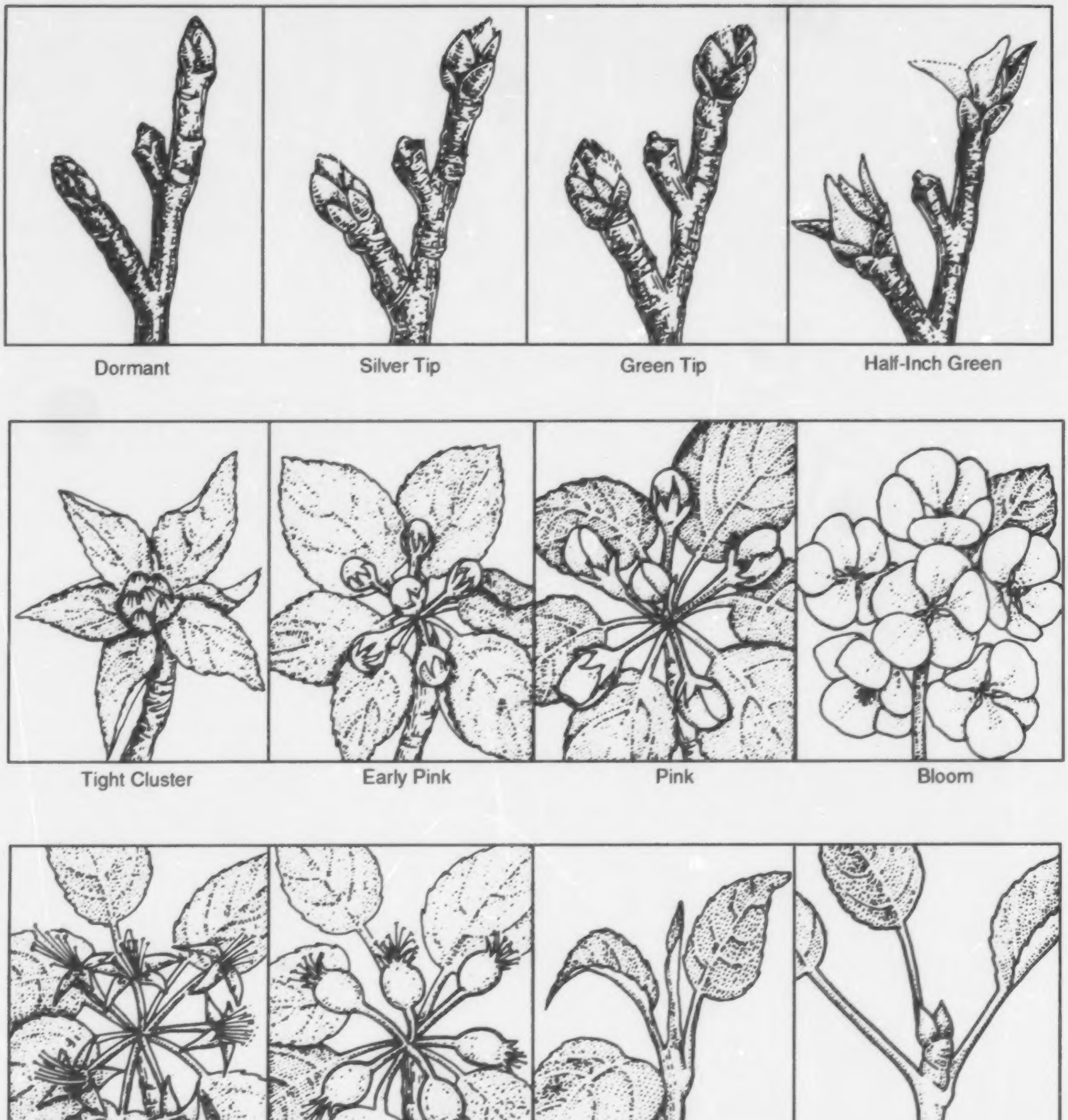
EXTREMELY TOXIC TO BEES

FURADAN 480F

This insecticide has caused more loss (confirmed cases of poisoning) to bees in Ontario than any other of the materials mentioned in this publication. Fruit growers and apiarists require close liaison when and where Furadan is used.

7. Apples

FIGURE 7–1. Apple Growth Stages



Dormant
Silver Tip
Green Tip
Half-Inch Green
Tight Cluster
Early Pink
Pink
Bloom
Petal Fall
Fruit Set
Terminal Growth
Regrowth

* reprinted with permission of Michigan State University.

Apple Nutrition

It is important to test and prepare soil before planting trees. To ensure long-term productivity of this perennial crop, prepare the soil through tillage and additions of organic matter well in advance of planting. For information on building and maintaining soil-organic matter see sections *Managing Soil Organic Matter* on page 28 and *Manure for Orchards*, below.

Prior to planting, ensure nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to Table 7–2, *Phosphorus & Potassium Soil Requirements Before Planting Apples*, on page 63. Phosphorus, potassium and lime are not readily leached through the soil and preplant applications are the most effective.

Manure for Orchards

Animal manure contains varying levels of nutrients and organic matter. The disadvantage of adding manure to orchards is that the nitrogen is mineralized over time. This slow release means that the orchard continues to receive nitrogen throughout the year. Excessive nitrogen can result in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue. This makes trees more susceptible to winter injury.

Do not put manure around newly planted trees because of potential winter injury problems. If manure is used, broadcast at moderate rates and work into the soil in late fall or early spring before planting.

Apply no more than 7 t/ha of poultry manure (20 m^3 liquid), 40 t/ha of cattle (100 m^3 liquid), 35 t/ha hog (65 m^3 liquid). Since manure is extremely variable in nutrient content, make sure you analyze it for nutrient content before application. See *Manure Analysis* on page 30 for more details. When manure is used, reduce the rate of fertilizer. Table 3–5, *Average Amounts of Available Nutrients for Different Types of Manure*, on page 29 shows the average composition of some manures and suggested reduction of fertilizer when manure is used.

pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, it can affect nutrient uptake and crop performance. To determine pH, take a soil sample. For information on soil sampling, consult the section *Soil Testing* on page 23.

Always take a soil sample before establishing a new planting. If lime is required, incorporate it during soil preparation. In established orchards, a soil sample in the tree row is recommended every 3 yr to be sure the pH is at a satisfactory level. If pH is low (acidic), apply lime to the sod cover in the fall, or before cultivation in the spring. The results will not be immediately evident because lime reacts slowly into the soil.

The target pH before establishing a new orchard is 6.5 on sandy soils and 6.0 on clay soils. If the pH in established orchards is above 5.6, lime is not needed. In established orchards, apply lime when the pH on clay loam soils drops below 5.1, and on sandy soils below 5.6. This will raise the soil pH, reducing the acidity, and also supply calcium. On soils low in magnesium use dolomitic lime, which is high in magnesium. Rates of application will vary with soil type and initial pH. The buffer pH indicates the rate of lime to apply. For information on lime, refer to *Soil Acidity And Liming* on page 26.

Leaf Analysis

In established plantings leaf analysis is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the tree. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests see *Plant Analysis* on page 25.

Nutrient uptake is affected by many orchard conditions. Consequently, each year the nutrient levels vary slightly depending upon the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the leaves and the relative amounts must be balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. Consult Table 7–1, *Nutrient Level Range of Mid-Shoot Leaves*, to find the optimum nutrient level ranges for apples.

Fertilizer requirements are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered in determining the fertilizer required.

Fertilizer for Apples

Fertilizer for Non-bearing Apples

The best time to effectively incorporate nutrients such as phosphorous, boron and lime into the soil is prior to planting the orchard. Nutrient levels in the topsoil considered adequate for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium, and 1,000–5,000 ppm calcium. Table 7–2, *Phosphorus & Potassium Soil Requirements Before Planting Apples*, on page 63 provides information on fertilizer rates prior to planting.

During the early years, before new trees bear their first crop, an annual application in early spring of nitrogen and potash is usually required. For suggested rates, refer to Table 7–3, *Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod,* on page 64 and Table 7–4, *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod**, on page 64. On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk since injury can result if placed too close. If the soil has been prepared properly, including deep cultivation and addition of organic matter, there should be an adequate supply of other nutrients to sustain the orchard in the juvenile years. On coarse-textured, infertile soils, the use of a starter solution at planting time (e.g., 10-52-10 or 20-20-20) may be helpful. High nitrogen levels can result in excessive growth and incomplete tree hardening. It is strongly recommend you use cover crops to check late season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass sown about July 1 take up much of the available nitrogen in the soil — checking tree growth.

Fertilizer for Bearing Apples

Most bearing orchards require annual applications of both nitrogen (N) and potassium (K) fertilizer. These 2 elements significantly affect growth and productivity.

Do not apply excessive amounts of nitrogen. Late or excessive applications result in poor fruit colour and quality. Also, available nitrogen late in the season may effect hardening off and increase the possibility of winter injury.

Using cover crops in cultivated orchards helps to lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil, limiting tree growth. In herbicide-treated strips under trees, weed growth late in the season takes up extra nitrogen, helping to harden off trees and improve fruit quality.

TABLE 7–1. Nutrient Level Range (% Dry Weight) of Mid–Shoot Leaves (taken last 2 weeks of July from mature trees)

	Nitrogen* (N)		Potassium (K)		Magnesium (Mg)
Leaf Analysis	**Low if below**	**High if above**	**Low if below**	**High if above**	**Low if below**
APPLE					
Delicious, Crispin	2.2	2.7	1.4	2.2	0.25
Empire, Spy	2.1	2.6	1.3	2.1	0.25
McIntosh, others	2.0	2.5	1.2	2.0	0.25

* Leaf nitrogen in non-bearing trees should be 0.2% higher.
Apple trees on M.9 or M.26 rootstocks should be 0.2% higher.

TABLE 7–2. Phosphorus & Potassium Soil Requirements Before Planting Apples

Soil Phosphorus	New Plantings of Apples*	Soil Potassium	New Plantings of Apples*
Soil Test (ppm P)	Phosphate (P_2O_5) req'd kg/ha	Soil Test (ppm K)	Potash (K_2O) req'd kg/ha
0–3	80 L		
4–5	60 L	0–15	180 L
6–7	50 L	16–30	170 L
8–9	40 M	31–45	160 L
10–12	20 M	46–60	140 L
13–15	0 H	61–80	110 L
16–20	0 H	81–100	70 M
21–25	0 VH	101–120	40 M
26–30	0 VH	121–150	20 M
31–40	0 VH	151–180	0 H
41–50	0 VH	181–210	0 H
51–60	0 VH	211–250	0 VH
61–80	0 E	250 +	0 E
80 +	0 E		

* For established apple trees, leaf analysis is used to estimate requirements of N, P + K.

Nitrogen (N)

Nitrogen is necessary for many tree functions including growth, fruit bud formation, fruit set and fruit size. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Cultivars differ in their nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also influence application rates. If pruning is to be severe, cut nitrogen rates back or eliminate for a year. Tree growth, foliage colour, fruit quality including colour and storability, nutrient balance in leaves and soil, are also important considerations.

Do not apply urea (46-0-0) to sod orchards since some of the nitrogen is lost by volatilization. There are several forms of nitrogen available, but ammonium nitrate (34-0-0) or calcium ammonium nitrate (27-0-0) is the most economical form of nitrogen to use. If using blended fertilizers for your orchard, request ammonium nitrate as the nitrogen source.

Nitrogen Rates

Given the variety of orchard systems, rootstocks, cultivars and soil types, the exact amount of nitrogen to apply will vary. Use leaf analysis to evaluate the nitrogen needs of your specific plantings. Table 7–3 on page 64 is an estimate of possible nitrogen requirements. When the tree canopy covers the space available, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Orchards grown under clean cultivation require about ½ the nitrogen required by orchards grown in sod.

For all apple cultivars do not exceed the maximum rates of 200 kg actual nitrogen per hectare per year, even in the case of a severe deficiency.

Nitrogen Placement and Timing

Apply nitrogen fertilizer in early April. In cultivated orchards broadcast nitrogen under the tree canopy. In sod orchards place the nitrogen in a band under the drip line, or in the herbicide strip.

Foliar Application of Nitrogen

Foliar applications of urea (46% nitrogen) have been used successfully on apples when weather or crop conditions resulted in a need for additional nitrogen at a critical time. Late applications may adversely affect fruit quality. On apples, use no more than 2.7 kg N/1,000 L water (6 kg urea) and apply at least 2,000 L/ha starting 7–10 days after petal fall, and spacing the sprays about 10 days apart. Do not apply more than 3 times. Do not apply later than the end of July, or fruit quality and winter survival of the tree could be adversely affected.

Urea sprays are not a substitute for soil applications if nitrogen is required.

Phosphorus (P)

Phosphorus is not required in large amounts by apple trees. With a few exceptions, the level of phosphorus in Ontario soils is generally adequate without any additional applications. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if you should apply this nutrient to the sod cover. Without a soil test, a complete fertilizer (100 kg/ha 10-20-20) could be broadcast and incorporated before seeding a cover crop in an orchard. If a soil test indicates, apply phosphorus before planting an orchard so it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for establishing and producing fruit trees.

TABLE 7–3. Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod*

TREE DENSITY

hectare	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600
acre	240	320	400	480	560	640	720	800	880	960	1,040
Tree Age (yrs)											
1	30	30	30	30	30	30	30	30	30	30	30
2	60	60	60	60	60	60	60	60	60	60	60
3	90	90	90								
4	120	120	120								
5	150	150	150								
6	180	170	168								
7	206	190	186								
8	232	210	204								
9	258	230									
10	284	250									
11	310										
12	336										
13 or older											

Use leaf analysis to determine nitrogen needs.

Reduce nitrogen rate by 1/2 if orchard is cultivated without sod between tree rows.

Do not exceed 200 kg of actual nitrogen/hectare/yr. regardless of number of trees/hectare.

* These are approximate values. The exact amount of nitrogen to apply is a function of soil nitrogen level, cultivar, rootstock, soil moisture, etc. The best way to determine nitrogen requirements is with regular leaf analysis.

TABLE 7–4. Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod*

TREE DENSITY

hectare	< 500	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600
acre	< 200	240	320	400	480	560	640	720	800	880	960	1040
Tree Age (yrs)												
1	80	80	80	80	80	80	80	80	80	80	80	80
2	80	80	80	80	80	80	80	80	80	80	80	80
3	80	80	80	80								
4	80	80	80	80								
5	80	80	80	80								
6	80	80	80	80								
7	80	70	63	52								
8	80	70	63	52								
9	80	70	63	52								
10	80	70	63	52								

Use leaf analysis to determine potash needs.

Do not exceed 800 Kg of 0-0-60/ha/yr regardless of number of trees/hectare.

* These are approximate values. The exact amount of muriate of potash to apply is a function of soil potassium level, cultivar, rootstock, soil moisture, etc. The best way to determine potash requirements is by leaf analysis.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance. Because an excess amount of potassium can lead to deficiency of magnesium (Mg), avoid unnecessary potassium applications. Potassium soil test values between 120–150 ppm are considered adequate when planting tree fruits. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, use approximate rates in Table 7–4 on page 64.

Apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard apple tree in a year, regardless of how severe the potassium deficiency. When fertilizing trees on dwarfing rootstocks, consult Table 7–4 on page 64 for approximate rates of muriate of potash to apply. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide to determining potassium requirements.

Placement and Timing

In early spring, either apply potassium separately or combined with nitrogen. Some orchardists make fall applications because of time constraints in the spring. However, some potassium may be lost by leaching over winter. For this reason, apply in spring if possible. In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

Magnesium (Mg)

Magnesium deficiency is becoming more evident in orchards, particularly when high rates of potash are used. Magnesium deficiency can lead to premature drop of fruit at harvest, especially with McIntosh. As magnesium is a part of the chlorophyll molecule, magnesium deficient trees have older leaves pale in colour. Leaf analysis is the best way to evaluate magnesium requirements.

Foliar sprays of magnesium are effective in correcting this deficiency for the current year only. (See Table 7–5, *Magnesium Foliar Sprays*, on page 66.) For more permanent correction, soil applications of magnesium are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. Apply magnesium sulfate separately or try it on a few trees first. Check manufacturer's label regarding mixing magnesium chelates[1] with pesticides.

For long-term corrections, soil applications of magnesium can be made; however crop response is not usually immediate. On some soil types a single early spring application of soil-applied magnesium may not be effective. A second or third application the following spring may be required before the magnesium level in the tree improves. To be sure that fruit drop is not a problem during this waiting period, apply foliar magnesium sprays for the first 2 yr, in addition to soil applications.

Use dolomitic limestone to supply magnesium and raise the soil pH on acidic soils. Where lime is not required, apply 5–7 kg/mature standard tree, and 3–4 kg/mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer containing approximately 21% potash and 11% magnesium. This material is applied in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. No further potash (e.g. 0-0-60) is needed, but apply nitrogen at recommended rates. Other sources of magnesium also work well as a soil application. If magnesium is being blended with the fertilizer, apply at least 80 kg of available magnesium per hectare when the fertilizer is spread.

Calcium (Ca)

A lack of calcium is associated with fruit problems in apples. In Ontario, bitter pit of apple is the most common problem associated with calcium.

Foliar applications of calcium (Ca) to apples reduces the incidence of bitter pit and cork spot. Where these disorders have been a problem in the past, beginning in mid–July, apply 4 foliar sprays 2 weeks apart. (See Table 7–6, *Calcium Foliar Sprays*, on page 66 for more details.) Where a greater amount of total calcium is required, additional applications can be made by beginning earlier (mid-June) or by continuing until harvest.

Calcium advances fruit maturity and adjustments in harvest timing may be required as a result of calcium foliar sprays.

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[1] Use chelates recommended for foliar sprays.

TABLE 7–5. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

TABLE 7–6. Calcium Foliar Sprays

Timing	Product	Rate	Notes
4 sprays spaced 2 weeks apart beginning in mid–July. Additional sprays can be applied up to harvest.	Calcium chloride* (77% flakes)	5 kg/1,000 L water	NOT recommended on McIntosh or Idared Wet tree to point of runoff. Pesticides may not be compatible — check label
	Calcium nitrate	9 kg/1,000 L water	Use only if leaf nitrogen is low. Do not apply later than the end of July. For pesticide compatibility consult labels.
	Other formulations including chelates	Consult label	

* When using calcium chloride, mix required calcium in a pail of water first to be sure all product is dissolved before adding slurry to spray tank.

Some formulations of calcium chloride ($CaCl_2$) have resulted in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective, therefore water volumes capable of wetting the entire tree are required. The more calcium you apply the better the control, however high concentrations of calcium can cause foliar burning.

Do not concentrate $CaCl_2$ (77% flakes) beyond 5 kg/1,000 L of water at the mid-July timing and no more than 7 kg/1,000 L for the applications at or beyond mid-Aug. Do not apply calcium formulations containing nitrogen after the end of July, or fruit quality and storability may suffer.

For all the formulations, be sure to consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual or elemental calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results, up to 12 kg/ha of actual calcium is often required in a total of 4 or more sprays. Calcium sprays may cause foliage and/or fruit injury if applied when low temperature and wet weather delay drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Recent studies with calcium sprays on McIntosh failed to show an advantage in fruit firmness and keeping quality when fruit was stored in a regular controlled atmosphere storage for 5 1/2 months. Limit applications of calcium to fruit that has a known deficiency and/or is prone to bitter pit or cork spot. For more information on calcium disorders, consult OMAFRA Factsheet *Bitter Pit Control in Apples*, Order No. 00-009.

Micronutrients for Apples

Deficiencies of micronutrients or trace elements are not widespread in Ontario apple plantings. Boron deficiency is perhaps the most common. Deficiencies of zinc, manganese, and iron show up occasionally, particularly in alkaline or high pH soils.

The desirable range for micronutrients is very small. More damage is possible with excesses amounts than with deficiencies. For this reason, do not apply micronutrients to apples except when deficiency is confirmed by leaf analysis or visible symptoms.

Apply only the nutrient that is deficient in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency occurs mainly on alkaline soils or on sandy knolls. Apples are the most sensitive of the fruit crops to boron deficiency. Symptoms include internal breakdown of highly coloured fruit that drops prematurely. A boron concentration in apple leaf tissue in mid-July of less than 20 ppm is considered deficient.

Apply foliar sprays of soluble boron fertilizers such as Solubor at rates supplying 0.2 kg of available boron/1,000 L water (1.0 kg Solubor/1,000 L). Two applications 10–14 days apart starting in early June is usually adequate. When there is a boron deficiency, spray at least 2,000 L/ha at each application. Other formulations of boron[1] are available. Consult manufacturer's label for rates and timing.

Recent research shows that you can apply boron as a spray to the herbicide strip under established trees to correct a deficiency where leaf levels are less than 20 ppm. Because of the narrow range between deficiency and toxicity, take care not to exceed recommended rates. Apply in fall or early spring so the boron will be carried further into the soil profile by rain or irrigation. The rate of boron to apply is 1–3 kg/ha of elemental boron (approximately 5–15 kg Solubor–20.5% B) to 1 ha of sprayed area. Ensure that the proper rate is applied based on spray width and row spacing. Boron applied to the soil surface may not be effective for the first year. In deficient situations apply a foliar spray for the first year that ground applications are made. Repeat applications every 3 yr if leaf B levels approach the deficient level.

Boron in excess causes yellowing of leaf edges and midrib, reduced yields and shortening storage life.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit-growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions).

In mild cases of deficiency there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. Normally, this is not serious. Leaf manganese concentrations below 20 ppm in mid-July are considered deficient. Fruit size, yield, and quality appear to be unaffected. If the condition is severe spray manganese sulfate at the rate of 1.3 kg of available Mn/1,000 L water (5 kg manganese sulfate) at 2,000 L/ha. Manganese chelates[1] are also effective in correcting manganese deficiency. Consult manufacturer's label for complete information on rates and timing.

On Red Delicious apples manganese toxicity can occur on coarse-textured soils when the soil is very acidic (pH below 5.0). The symptoms known as "measles" are raised pimples on the bark underlain by dark brown spots. Other visual symptoms are leaf chlorosis, tip dieback, early leaf abscission and reduced flower bud development and shoot growth. Correction is sometimes possible by working lime into the soil to raise pH. Sample the soil and add lime if pH is low prior to planting.

Iron (Fe)

Iron deficiency, commonly termed "lime-induced chlorosis," is not widespread in Ontario orchards. Occasionally, 1 or 2 trees in an orchard exhibit iron-deficiency symptoms. Often these trees are located near the site of previous lime or building plaster storage, etc., where the soil pH is abnormally high.

Iron deficiency causes interveinal chlorosis of young leaves. As the condition grows more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the tree is affected. Iron chelates[1] make correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

Zinc (Zn)

Zinc deficiency has been identified in some apple orchards in eastern Ontario. The symptoms of this deficiency are short internodes, small narrow leaves, interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes", giving rise to the typical "rosette" and "little leaf" description for zinc deficiency. Except in severe cases, only a few shoots on an otherwise normal tree shows symptoms. Leaf zinc levels below 15 ppm indicate a deficiency.

Zinc sulfate supplying 3.6 kg of Zn/1,000 L water as a dormant spray in early spring is effective.

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[1] Use chelates recommended for foliar sprays.

Dilute sprays in June of zinc sulfate ($ZnSO_4$) or chelate[1] containing 0.35 kg Zn/ha (1 kg 36% $ZnSO_4$ or 5 L 6.5% Zn chelate[1]) are effective in correcting zinc deficiency on fruit trees. A fungicide for disease control that contains available zinc can be an asset in orchards continually low in zinc. Consult manufacturer's label for available zinc concentrations in the formulation.

Warning: Do not concentrate nutrient sprays. Do not spray at temperatures above 25°C. Fruit injury is possible under these conditions.

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[1] Use chelates recommended for foliar sprays.

Apple Calendar

Read the label and follow all safety precautions.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Dormant			
San Jose scale European fruit scale Lecanium scale	- Superior "70" Oil	60 L	Apply full rate of oil in 2,000–3,000 L of water/ha. 3,000 L will give best results. On large standard trees, use 90 L of oil in 4,500 L of water/ha. Do not apply full rate of oil more than once/season. Test the stability of the emulsion by shaking in a jar. Do not use oil within 48 hr of freezing temperatures. Do not use oil within 14 days of Captan or Maestro.
Oil may cause bark injury on Red Delicious, Empire and Mutsu (Crispin).			
Green Tip up to Half-Inch Green			
Scab protectants	• Polyram DF • Captan 80 WDG or [4]Maestro 80 DF • [4]Dikar • Manzate 200 DF or Dithane DG or [3]Penncozeb 75 DF • [4]Vangard 75 WG	6.00 kg 3.60 kg 3.75 kg 6.75 kg 6.00 kg 6.00kg 6.00 kg 370 g	Apply fungicide before spore release and keep growing leaves coated. It is generally advisable to alternate materials in a spray program. Read *Managing Apple Scab* on page 77–82. When used in a full season program, Dikar will suppress orchard mites. Higher water volumes aid in mite suppression. Consult label. Use Vangard as a protectant type fungicide. Make no more than 2 applications/ season, prebloom only. Vangard does not control other foliar or fruit diseases.
Half-Inch Green to Tight Cluster			
European red mite	• Superior "70" Oil	60 L	Do not apply full rate of oil more than once/ season. Apply full rate of oil in 2,000–3,000 L of water/ha. 3,000 L gives best results. Test the stability of the emulsion by shaking in a jar. On large standard trees, use 90 L of oil in 4,500 L of water/ha. Apply Superior oil for the control of European red mite before overwintering eggs hatch. Usually the best timing is between **Half-Inch Green and Tight Cluster** when temperatures are getting warmer. Do not use oil within 14 days of Captan or Maestro.
Oil may cause bark injury on Red Delicious, Empire and Mutsu (Crispin).			
Rosy apple aphid	• [3]Pirimor 50 DF	1.7 kg	Do not make more than 2 applications/ season.
Scab	• Polyram DF • Captan 80 WDG or [4]Maestro 80 DF • [4]Dikar • Manzate 200 DF or Dithane DG or [3]Penncozeb 75 DF • [4] Vangard 75 WG • Nova 40 W plus Dithane DG • Nova 40 W plus Polyram DF • Nova 40 W plus [4]Maestro 80DF • [2]Nustar plus Manzate 200 DF • [2]Nustar plus [4]Maestro 80 DF • [6]Sovran With Superior Oil use 1 of: • Polyram DF • Dithane DG or Manzate 200 DF	6.00 kg 3.60 kg 3.75 kg 6.75 kg 6.00 kg 6.00 kg 6.00 kg 370 g 340 g 3.00 kg 340 g 3.00 kg 340 g 1.90 kg 100 g 3.00 kg 100 g 1.90 kg 240 g 6.00 kg 6.00 kg 6.00 kg	See *Managing Apple Scab* on page 77–82. See *Use of Sterol-Inhibiting Fungicides* on page 80. Add fungicide to tank when ¼ to ½ full of water and mix thoroughly. Add Superior Oil last when tank is at least ¾ full of water. **Note:** Oil may cause bark injury to Red Delicious, Empire, and Crispin.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs. [4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Use of Sovran	**Sovran represents a new family of fungicides called Strobilurins. Sovran has good protectant, postinfection and antisporulant activity on apple scab and powdery mildew.** **Because of its mode of action, it is important to follow resistance management strategies carefully. Do not use Sovran earlier than Tight Cluster and apply in blocks of 2 applications, 10 days apart. Use another chemical family for 2 applications before returning to Sovran. Use no more than 4 applications of Sovran/season. After the last application of Sovran, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check label for details.**		
Powdery mildew	Use one of the products listed at **Tight Cluster to Pink**		
Tight Cluster to Pink			
Tentiform leafminer	- *Pounce	520 mL	*Pyrethroids will also control spring feeding caterpillars and tarnished plant bugs. Do not apply a pyrethroid more than once/season. Consult agriphone for timing (if available). Apply Confirm at first egg hatch. Confirm suppresses leafminer populations. Continue monitoring after application. Do not apply more than twice/season.
	- *Decis 5EC	250 mL	
	- *Ripcord 400 EC	250 mL	
	or *Cymbush 250EC	400 mL	
	- [3]*Matador 120 EC	83 mL	
	- Confirm 240 F	1.00 L	
Scab	Use one of the fungicides listed at **Half-Inch Green to Tight Cluster**, page 69. See also *Control Under Adverse Weather Conditions* on page 80.		
Powdery mildew	- Nova 40 W	340 g	Begin application at tight cluster and continue to **First Summer Spray**. If powdery mildew was prevalent the previous yr., apply Nova 40 W or Nustar beginning at **Green Tip**. Additional sprays beyond **First Summer Spray** may be needed on susceptible varieties or if disease pressure is severe. Do not apply more than 4 Nova 40 W or Nustar applications/season. Do not use Sulphur or Kumulus on Delicious. Use of Sulfur or Kumulus may result in elevated populations of red mite and scale insects. See Sovran comments for scab at **Tight Cluster to Pink.** Benlate may cause russetting on sensitive varieties such as Golden Delicious, Rome or Stayman.
	- [2]Nustar	200 g	
	- [4]Dikar	6.75 kg	
	- Benlate 50 WP	550 g	
	plus Polyram DF	3.35 kg	
	- Benlate 50 WP	550 g	
	plus Manzate 200 DF	3.25 kg	
	- Microscopic Sulphur	19.5 kg	
	- Kumulus DF	22.5 kg	
	- [6]Sovran	240 g	
Cedar apple rust Quince rust	- Ferbam 76 WDG	4.80 kg	Include in each spray up to and including **First Summer Spray**. Ferbam may cause russetting on Golden Delicious and other sensitive varieties. When used for a scab control program Nova 40 W controls rust diseases. For specifically controlling rust scab diseases, begin applications of Nova 40 W plus Dithane DG at **Tight Cluster** and continue at 7–10 day intervals to **First Summer Spray**. Do not exceed 4 applications of Nova 40 W/season.
	- [4]Dikar	6.75 kg	
	- Polyram DF	6.00 kg	
	- Dithane DG	6.00 kg	
	or [3]Penncozeb 75 DF	6.00 kg	
	- Nova 40W	340 g	
	plus Dithane DG	3.00 kg	
Plant bugs	- Cygon 480	1. 90 L	Where troublesome, add to 1 spray before bloom. Will also control spring-feeding caterpillars and green fruitworm.
Spring-feeding caterpillars Green fruitworm	- [4]Guthion Solupak	2.30 kg	This spray is not necessary if a pyrethroid was applied for tentiform leafminer. Make no more than 3 applications of Zolone Flo/season.
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper 50 W	2.30 kg	
	- Zolone Flo	2.00 L	
	- Imidan 50 WP	3.75 kg	
Full Pink			
Scab	Use 1 of the fungicides listed at **Half-Inch Green to Tight Cluster**. See *Control Under Adverse Weather Conditions* on page 80.		
European red mite	- Carzol SP	1.10 kg	Miticides are most effective when used alone. Carzol is harsh on beneficial mite species and bees. Application before **Petal Fall** is preferred.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Resistance to miticides is increasing in Ontario orchards.
See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 41.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Rosy apple aphid	- [3]Pirimor 50 DF - Zolone Flo - Cygon 480	1.70 kg 2.00 L 3.75 L	Preferred time for control. See section on *Bee Poisoning* on page 58. Make no more than 3 applications of Zolone Flo/season. Make no more than 2 applications of Pirimor/season. Cygon may cause russetting.
Obliquebanded leafroller	- *Dipel 2X DF or *Foray 48BA or *Bioprotec CAF - Success 480 SC - Confirm 240 F	1.12 kg 2.80 L 4.00 L 182 mL 1.00 L	See *Obliquebanded Leafroller* on page 85. *Two applications of *B.t.* products at 5–7 day intervals may be required to cover extended activity of the larvae. For best results when using *B.t.* products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. When applied for leafroller control, these products also control other caterpillars. Apply Success when larvae are small. Monitor populations and re-apply as necessary on a 7–10 day schedule. Make no more than 3 applications. Avoid treating sequential generations. Spray solution should be above pH 6.0. Make no more than 2 applications of Confirm/ yr. Accurate timing of Confirm is important. See label for specific timing.

Bloom

Do not apply insecticides while apple trees are in bloom.
See *Bee Poisoning* on page 58.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Scab	- Polyram DF - Captan 80 WDG or [4]Maestro 80 DF - [4]Dikar - Manzate 200 DF or Dithane DG or [3]Penncozeb 75 DF - Nova 40 W plus Dithane DG - Nova 40 W plus Polyram DF - Nova 40 W plus [4]Maestro 80DF - [2]Nustar plus Manzate 200 DF - [2]Nustar plus [4]Maestro 80 DF - [6]Sovran	6.00 kg 3.60 kg 3.75 kg 6.75 kg 6.00 kg 6.00 kg 6.00 kg 340 g 3.00 kg 340 g 3.00 kg 340.0 g 1.90 kg 100 g 3.00 kg 100 g 1.90 kg 240 g	See *Control Under Adverse Weather Conditions* on page 80. Check Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266. See *Use of Sterol-Inhibiting Fungicides* on page 80. Do not use Sovran earlier than **Tight Cluster** and apply in blocks of 2 applications, 10 days apart. Use another chemical family for 2 applications before returning to Sovran. Use no more than 4 applications of Sovran/season. After last application of Sovran, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check label for details.
Fire blight	- Streptomycin 17	600 g/1,000 L	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Streptomycin 17 is UV light sensitive and is only effective for 2–3 days. Reapplication is needed after 2–3 days if warm, wet conditions (above 20°C) prevail. Two–4 sprays during bloom may be required for fire blight control. To avoid resistance use a maximum of 4 sprays/season. See *Fire Blight of Apple* on page 82 for details.

Petal Fall (Calyx) When most petals have fallen

Diseases and Insects	Comments
Scab	Use one of the fungicides recommended at **Bloom**. See *Control Under Adverse Weather Conditions* on page 80.

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[1] *Minimum period for re-entry is 4 hrs.* [2] *Minimum period for re-entry is 12 hrs.* [3] *Minimum period for re-entry is 24 hrs.*
[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Tentiform leafminer	• [3]Admire • *Pounce • *Decis 5 EC • *Ripcord 400 EC or *Cymbush 250 EC • *[3]Matador 120 EC • [3]Lannate • [3]Agri-Mek 1.9 EC	380 mL 520 mL 250 mL 250 mL 400 mL 83 mL 1.60 kg 750 mL	Apply Admire when sap feeders are present. Will also control green apple aphid, rosy apple aphid, mullein bug and white apple leafhopper at this timing. No more than 2 applications/season. In years where leafminer egg hatch is delayed, a *pyrethroid can be applied at petal fall when first sap-feeding mine on underside of cluster leaves is detected. This treatment also controls mullein bug, tarnished plant bug and spring feeding caterpillars. Do not apply pyrethroids more than once/season. If leafminer egg hatch is well underway apply Lannate when first tissue-feeding mine is detected on the upper surface of the cluster leaves. Do not apply Lannate to Early McIntosh or Wealthy varieties. Apply Agri-Mek when first sap-feeding mine on underside of fruiting spurs is detected. Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L of Superior Oil and a minimum of 1,000 L of water/ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned cultivars. **Do not use within 14 days of a captan application.** Do not apply more than once/season. Agri-Mek is best applied alone. Agri-Mek also controls ERM and TSSM. See comments for European red mite control at **First Summer Spray.**
Rosy apple aphid	• [3]Admire • [3]Pirimor 50 DF • Zolone Flo • Cygon 480	230 mL 1.70 kg 2.00 L 3.75 L	Admire applied at this time also controls green apple aphid, white apple leafhopper and tentiform leafminer. Make no more than 2 applications of Admire/season. Cygon may cause russetting. Cygon also controls oystershell scale.
Mullein leaf bug	• [3]Admire • Diazinon 50 WP • [3]Lannate T-N-G • Decis 5 EC	380 mL 3.25 kg 1.60 kg 200 mL	Timing is critical. Admire applied at this time also controls green apple aphid, rosy apple aphid, white apple leafhopper, and tentiform leafminer. Make no more than 2 applications of Admire/season.
Oystershell scale	• [4]Guthion Solupak or [4]Sniper 50 W	1.8 kg 2.0 kg	Apply as soon as petals are off.
Plum curculio Caterpillars	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper 50 W • Imidan 50 WP • [3]Zolone Flo	2.30 kg 2.30 kg 2.30 kg 3.75 kg 3.00 L	
European apple sawfly	• [4]Guthion Solupak or [4]Sniper 50 W	2.30 kg 2.30 kg	Apply as a special spray to orchards where there has been a history of damage.
European red mite	• Apollo SC • Carzol SP	300 mL 1.10 kg	Apollo kills mite eggs. Apply when mites are mostly in the egg stage, and before there are more than 3 active mites/leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water/ha. Make no more than 1 application/ yr. Carzol is harsh on beneficial mite species and bees.
Blister spot	• [2]Aliette WDG	2.00 kg	Begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not exceed 3 applications. Do not mix with copper compounds.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	**Materials**	**Amount/ha Trees 4.5–5.5 m high**	**Comments**
Obliquebanded leafroller	• *Dipel 2X DF or *Foray 48BA or *Bioprotec CAF • [1]Success 480 SC • Confirm 240 F • [3]Lannate	1.12 kg 2.80 L 4.0 L 182 mL 1.00 L 1.60 kg	See *Obliquebanded Leafroller* on page 85. When applied for leafroller control, these products also control other caterpillars. *Two applications of *B.t* products at 5–7 day intervals may be needed to cover extended activity of larvae. For best results when using **B.t.* products acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. Apply Success when larvae are small. Monitor populations and re-apply as necessary on a 7–10 day schedule. Make no more than 3 applications. Avoid treating sequential generations. Spray solution should be above pH 6.0. Do not apply Confirm more than 2 times/season. Accurate timing of Confirm is important. See label for specific timing. Lannate is most effective on 4th and 5th instar larvae. Do not use Lannate more than once/season.
Powdery mildew	Use one of the fungicides listed at **Tight Cluster to Pink**		
First Summer Spray (7–10 days after CALYX)			
Scab	Use one of the fungicides recommended at **Bloom.** An extra scab spray may be required between **Calyx** and **First Summer Spray**. See *Control Under Adverse Weather Conditions* on page 80.		
Plum curculio	Use one of the insecticides listed under **Petal Fall (Calyx).**		
Fire blight	• Streptomycin 17	600 g/1,000 L	To control shoot blight especially if blossom blight has occurred.
European red mite Two-spotted spider mite	• Apollo SC • [3]Agri-Mek 1.9 EC	300 mL 750 mL	Apply Apollo no later than 14 days after petal fall. Apollo kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites/leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water /ha. Make no more than 1 application of Apollo/yr. Apply Agri-Mek when mites are in the nymph stage and no later than 21 days after petal fall. Apply with 10 L superior oil and a minimum of 375 L of water /ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned varieties. **Do not use within 14 days of a Captan application. Do not apply more than once per season.** Ideally, alternate yearly with other early season miticides (e.g., Superior Oil, Apollo). Agri-Mek will also control tentiform leafminer. Miticides are best applied alone. Resistance to miticides is increasing in Ontario orchards. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 41.
Rosy apple aphid	• [3]Admire • [3]Pirimor 50 DF • Zolone Flo • Cygon 480	230 mL 1.70 kg 2.00 L 3.75 L	Admire applied at this time also controls green apple aphid and white apple leafhopper. Make no more than 2 applications of Admire/season. Cygon may cause russetting.
Powdery mildew	Use one of the fungicides listed under **Tight Cluster to Pink**		
Blister spot	• Copper 53W	3.00 kg	To reduce the incidence of blister spot lesions on Crispin and other sensitive varieties, apply up to 3 applications of Copper 53W beginning 10 days after **Petal Fall**. Use hydrated lime as a safener (to reduce the risk of phytotoxicity) at a rate of 6 kg per 1 kg of Copper 53W per 1,000 L of water. Apply 3,000 L of water/ha.

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[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Subsequent Summer Sprays			
Scab	Until the end of the primary scab season use one of the fungicides recommended at **Bloom.** For summer (secondary) scab infections, use one of the following:		
	• Captan 80 WDG	3.60 kg (1.8)	**If scab is controlled in your orchard use the lower rate given in brackets.** If secondary lesions develop, see *Deactivation of Established Scab Lesions* on page 81. Do not apply Polyram, Dikar, Manzate, Dithane or Penncozeb within 45 days of harvest.
	or [4]Maestro 80 DF	3.75 kg (1.9)	
	• [4]Dikar WP	6.75 kg (5.0)	
	• Polyram 80 DF	6.00 kg (4.5)	
	• Manzate 200 DF	6.00 kg (4.5)	
	or Dithane DG	6.00 kg (4.5)	
	or [3]Penncozeb 75 DF	6.00 kg (4.5)	
Sooty blotch /fly speck	• Captan 80 WDG	3.60 kg	Repeat application of Captan or Maestro in 2 wks. Captan or Maestro provide some protection against black rot. All materials provide some protection against other storage rots.
	or [4]Maestro 80 DF	3.75 kg	
	• Zineb 80 W	3.75 kg	
Codling moth	• Imidan 50 WP	3.75 kg	Use pheromone traps to time sprays. See Pub. 310, *Integrated Pest Management for Ontario Apple Orchards* for information on how to monitor for this pest. Guthion and APM control scale crawlers. Zolone also controls aphids. Apply Confirm at first egg hatch. Confirm may also suppress leaf-feeding caterpillars. Do not apply more than twice/season. Confirm **does not** control apple maggot. Accurate timing of Confirm is important. See label for specific timing.
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper 50 W	2.30 kg	
	• Zolone Flo	2.00 L	
	• Sevin XLR Plus	3.10 L	
	• Confirm 240 F	1.00 L	
Apple maggot	• Imidan 50 WP	3.75 kg	Base initial spray on visual trapping (see Pub. 310, *Integrated Pest Management for Ontario Apple Orchards*). Make subsequent applications at 14–21 day intervals or as required based on monitoring. Cygon may not give sufficient apple maggot control for fresh market apples and may cause russetting on some varieties.
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper 50 W	2.30 kg	
	• Zolone Flo	3.00 L	
	• Cygon 480	3.75 L	
	• Sevin XLR	6.25 L	
	plus Diazinon 50 W	3.00 kg	
Special Summer Sprays			
Blister spot	• Copper 53 W	3.00 kg	See comments on blister spot control under **First Summer Spray.**
Green apple aphid	• [3]Admire	230 mL	Make no more than 2 applications of Admire/season. Diazinon, Cygon and Zolone also control codling moth. Pirimor, Admire, Thiodan and Endosulfan also control white apple leafhopper. Zolone also controls woolly apple aphid. Cygon may cause russetting.
Rosy apple aphid	• [3]Pirimor 50 DF	1.70 kg	
	• Zolone Flo	2.00 L	
	• Cygon 480	3.75 L	
	• Thiodan 50 WP	4.50 kg	
	or Endosulfan 50 W	4.50 kg	
	• Diazinon 50 W	3.00kg	
Woolly apple aphid	• [3]Pirimor 50 DF	1.70 kg	Use high volumes of water. Spray coverage of trunk and scaffold limbs is essential. Repeat application in 14 days if woolly apple aphid is still present. Zolone is effective only if used in a cover spray program. Pirimor also controls white apple leafhopper.
	• Malathion 25 W	6.75 kg	
	• Zolone Flo	2.00 L	
White apple leafhopper	• [3]Admire	200 mL	Spray when large numbers of nymphs (2–5 per leaf) are observed. Control of adults is very difficult. There are 2 generations of nymphs/yr. generally in mid-June and early Aug. When Admire is applied for 1st generation, active in June, it also controls green apple aphid and rosy apple aphid. Make no more than 2 applications of Admire/season.
	• [3]Pirimor 50 DF	1.70 kg	
	• Carzol SP	1.10 kg	
	• Sevin XLR plus	3.10 L	
	Endosulfan 50 W	2.60 kg	
Potato leafhopper	• Endosulfan 50 W	2.60 kg	

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs. [4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha Trees 4.5–5.5 m high	Comments
Tentiform leafminer	• [3]Lannate TNG • *Pounce • *Decis 5EC • *Ripcord 400 EC or *Cymbush 250 EC • *[3]Matador 120 EC	1.60 kg 520 mL 250 mL 250 mL 400 mL 83 mL	Apply Lannate when new sapfeeder mines appear on the lower leaf surface and first-tissue feeder is seen. Do not apply Lannate to Early McIntosh or Wealthy. *Use of synthetic pyrethroids for summer generations of tentiform leafminer is discouraged. Pyrethroids do not give effective control of larvae within the mines.
Dogwood borer Apple bark borer	• Pounce plus Superior Oil	22 mL/100 L water with 2 L Oil	Soak the trunk. Make 2 applications at 2–3 week intervals when adults are flying (late June–early Aug.).
Obliquebanded leafroller	• *Dipel 2X DF or *Foray 48BA or *Bioprotec CAF • [1]Success 480 SC • Confirm 240	1.12 kg 2.80 L 4.00 L 182 mL 1.00 L	When applied for leafroller control, these products also control other leaf-feeding caterpillars. *Two–3 applications of *B.t.* products at 5–7 days intervals may be needed to cover extended activity of the larvae. For best results when using *B.t.* products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. Apply Success when larvae are small. Monitor populations and re-apply as necessary on a 7–10 day schedule. Make no more than 3 applications. Avoid treating sequential generations. Spray solution should be above pH 6.0. Apply a second spray of Confirm 10–14 days after the first application. Do not apply Confirm more than 2 times/season. Accurate timing of Confirm is important. See label for specific timing.
European red mite Two-spotted spider mite Rust mite	• [3]Pyramite • Kelthane 50 W • Carzol SP	300 g 3.25 kg 1.10 kg	Pyramite is most effective when applied to immature stages (but not eggs). A higher rate of 600 g/ha may be necessary if outbreaks of two-spotted mites occur. Carzol is harsh on beneficial mite species. Use established spray thresholds to time miticide applications. Miticides are best used alone. Apply each miticide only once/season to delay development of resistance. Use a minimum of 1,000 L/ha of water when applying summer miticides. Resistance to miticides is increasing in Ontario orchards. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 41.
Pinpoint and storage scab	Use one of the fungicides recommended for secondary scab in **Subsequent Summer Sprays**. Do not use fungicides closer than the stated interval to harvest. (See Table 13-1, *Pesticides Used on Fruit Crops in Ontario,* on page 266.)		
Postharvest Treatment			
Blue mould Grey mould	• Mertect SC	0.5 L/500 L	For use in dip tank or drencher. Continuous agitation required. Follow label instructions. **Does not control blue mould (Penicillium) or grey mould (Botrytis), which is resistant to benzimidazole fungicides. (e.g., Benlate).**

Visit the apple page on the OMAFRA Web site at www.gov.on.ca/OMAFRA/english/crops/hort/apples.html.

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[1] *Minimum period for re-entry is 4 hrs.* [2] *Minimum period for re-entry is 12 hrs.* [3] *Minimum period for re-entry is 24 hrs.*
[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Guidelines for Protecting Non-Bearing Apple Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended to be used for protection of bearing orchards. Other protective measures include removing neglected fruit trees in the area, careful selection of intercrops (where used) and a clean, weed-free environment. Rates are for dilute spraying. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Materials	Amount/ 1,000 L	Comments
Early Spring			
Phytophthora collar rot			See *Phytophthora Collar Rot Control* on page 83.
First Spray			
Scab Powdery mildew Cedar apple rust	• [4]Dikar	2.00 kg	When green tissue shows. Repeat at 7–10 day intervals if wet weather occurs until late June.
Prebloom			
Tentiform leafminer	• Pyrethroid		See products listed for tentiform leafminer on page 70. (except Confirm). Consult label for rates.
Leaf feeding insects	• Imidan 50 WP	1.25 kg	Before blossoms open in adjacent bearing orchards. Apply when caterpillars are small. Include with a fungicide spray. Not necessary if a pyrethroid was used for tentiform leafminer.
Bloom			
Fire blight	• Streptomycin 17	600 g	Avoid overstimulating growth. See *Fire Blight of Apple* on page 82.
Summer Sprays			
Leaf feeding insects	• Imidan 50 WP	1.25 kg	This spray will also control potato leafhopper.
Aphids	• [3]Admire • [3]Pirimor 50 DF • Cygon 480	75 mL 500 g 1.25 L	Spray if insects become abundant at any time.
White apple leafhopper	• [3]Admire • [3]Pirimor 50 DF • Endosulfan 50 W	65 mL 500 g 2.6 kg/ha	
Potato leafhopper	• Endosulfan 50 W	2.6 kg/ha	
Tentiform leafminer	• [3]Admire • [3]Vydate L	125 mL 3.0 L	Vydate is very toxic to applicator. Timing is critical. If mines are visible on underleaf surface, consult crop advisor.
Mites	• [3]Pyramite	100 g	Check foliage frequently for mite injury. Spray if more than 7–10 mites/leaf are observed or at first sign of leaf bronzing.
Buffalo treehopper			Follow clean cultivation practices or remove legumes from cover crop.
Phytophthora collar rot	See page 83.		
Root lesion nematode	See *VYDATE L — Post-plant Treatment* on page 47.		

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Apple Disease Control

Managing Apple Scab

Apple scab, *Venturia inaequalis,* is the most serious fungal disease of apple in Ontario. The fungus attacks foliage, blossoms and fruits by defoliating trees and causing fruit to be unmarketable. In addition to cultivated apple, apple scab also attacks flowering crab apples, mountain ash and firethorn.

Primary Infection Periods

Once apple trees break dormancy and there is green tissue present, a primary infection can occur if the following 3 conditions are met:

- mature ascospores are present
- moisture is available
- ascospores are discharged.

Presence of mature ascospores

Mature ascospores are always present at bud break. The number of ascospores present depends on the amount of inoculum in the overwintering leaves (i. e., whether it is a low or high inoculum orchard). The rate at which ascospores mature in the overwintering leaves on the orchard floor is determined mainly by temperature.

Cornell University has developed a model relating temperature to spore maturation (expressed in degree-days Celsius or DDC). The model allows one to predict the percentage of the season's ascospores that have matured. (See Figure 7–2, *Cumulative Percentage of Ascospores Matured at Various Degree-Day Accumulations.*) Daily accumulated degree-days are calculated as follows:

DDC = (Daily max. °C + Daily min. °C) /2 – 0°C

For example, on a day with a high of 10°C and a low of 2°C, the accumulated degree-days will be 6 DDC. If temperatures are below 0 °C, (i.e., a negative number), then use a value of 0 DDC. Begin degree-day accumulations at *bud break,* defined as the day on which at least ½ of the fruit buds on McIntosh are between silver tip and green tip.

The degree-day accumulations are used to estimate the percentage of mature ascospores from the central curve in Figure 7–2. The upper and lower curves are the upper and lower 90% confidence limits around the estimates on the graph. The width of the 90% confidence interval is a statistical measure of the precision of estimated maturity. The estimate should fall within this range 90% of the time.

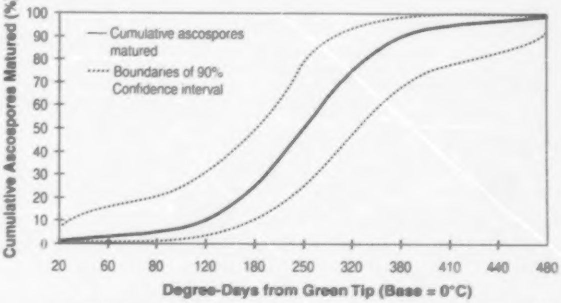

FIGURE 7–2. Cumulative Percentage of Ascospores Matured at Various Degree-Day Accumulations

Two points of particular interest on this graph are:

- At 125 DDC — there is a rapid maturation of ascospores indicating a higher risk of infections occurring.
- At 418 DDC — over 95% of the ascospore supply should be depleted 90% of the time if sufficient rain events have occurred. (See Table 7–7, *Percentage of Available Ascospores Discharged under Various Environmental Conditions.*) This marks the end of the primary infection season. With this model the growers can obtain a site-specific forecast of ascospore maturity and discharge for their own orchard(s).

TABLE 7–7. Percentage of Available Ascospores Discharged under Various Environmental Conditions

Type of Rain Event	% Available Ascospores
Night rain only	5%
Day rain < 0.25 cm; < 10°C	25%
Day rain > 0.25 cm; < 10°C	50%
Day rain < 0.25 cm; > 10°C	50%
Day rain > 0.25 cm; > 10°C	90%

Ascospore release

Ascospores are released when there is rain to wet the pseudothecia on the dead leaves. Most of the available mature spores are discharged within 2 hr following the start of a rainy period. Ascospore release is strongly light dependent, and only a small percentage of available ascospores is released at night, (from 7 p.m. to 8 a.m. Eastern Daylight Savings Time (EDST)). Ascospores are not released to any significant extent during nighttime hours in low inoculum orchards. In an orchard where the ascospore inoculum is high, although the percentage of ascospores released is small, the total number of ascospores released is large and can result in a significant primary scab infection.

In a low-inoculum orchard, the length of wetting period is calculated using the following method.

- When rain begins during the day, between 8:00 a.m. and 7:00 p.m. (EDST) count the hours of leaf wetness from the 1st hour rain was recorded until the leaves are dry.
- When the rain begins at night, between 7:00 p.m. and 8:00 a.m. EDST, count the hours of leaf wetness from 8:00 in the morning until the leaves are dry.

For a high-inoculum orchard, calculate the length of wetting period from the start of the rain until the leaves are dry, regardless of the time of day.

Available moisture

Rainfall is needed for the release of ascospores, and the leaves and fruit must be wet in order for infection to take place. The length of the wetting period required for infection varies with temperature. This relationship between hours of wetting and temperature is outlined in Table 7–8, *Relationship of Temperature and Moisture to Apple Scab Infection.*

Once the length of the wetting period has been determined, calculate the average temperature during this interval and check Table 7–8 to see if leaves were wet long enough for an infection to occur.

Secondary Infection Periods

Secondary scab infections occur when splashing rain spreads conidia developed from primary scab lesions on leaves. As with primary infections, secondary infections only occur if moisture initiated by rainfall is present for a long enough period at a given temperature. Secondary infections can occur day or night so all secondary infections are calculated from the beginning of the wetting period regardless of the time of day. Continued infections through the summer result from lesions caused by conidia.

TABLE 7–8. Relationship of Temperature and Moisture to Apple Scab Infection

	Minimum Number of Hours of Leaf Wetness Required	
Average Temp. (°C)	Primary Season (Ascospore Infection)	Secondary Season (Conidia Infection)
1	40	37
2	34	33
4	27	26
5	21	23
6	18	20
7	15	17
8	13	15
9	12	13
10	11	12
11	9	10
12	8	9
13	8	9
14	7	9
15	7	9
16	6	9
17	6	8
18	6	8
19	6	8
20	6	7
21	6	7
22	6	7
23	6	8
24	6	9
25	8	11
26	11	14

Adapted from: Stensvand, Gadoury, Amundsen, Semb and Seem, 1997 Phytopathology 87: 1046-1053.

Contribution of intermittent rain and dew to infection periods

Periods of dew or high humidity (over 90%) also contribute to a wetting period, but are significant only if preceded by rain. Wet periods during an intermittent rain should be added together to determine the length of an infection period, unless the wet periods are separated by 10 hr or more of dry, sunny weather.

TABLE 7–9. Relationship of Temperature, Hours of Wetting and Weeks after Full Bloom to Secondary Apple Scab Infection of Fruit[1]

	Weeks After Full Bloom			
	1	5	10	15
Average Temp. °C	Hours of Wetting for 2% Fruit Infection			
10	13	26	37	45.5
12	10	21.6	31	38
14	8.5	18.5	26.5	32.5
16	7.5	16	23	28.5
18	6.5	14.5	20.5	25.5
20	6	13	18.5	23

[1] Adapted from Schwabe et al., 1984
Cultivars tested were: Golden Delicious, Starking Delicious, Starkrimson Delicious, White Winter Pearmain.

Fruit infection

As the fruit matures it progressively takes a longer wetting period for infection by apple scab to occur. Table 7–9, *Relationship of Temperature, Hours of Wetting and Weeks after Full Bloom to Secondary Apple Scab Infection of Fruit*, outlines this relationship.

The wetting periods required for infection of fruit by apple scab are longer than those required for leaf infection. For orchards with only light primary leaf infection, the longer infection times required for fruit may be followed in those orchards where only fruit scab is of concern. If unchecked during the growing season, leaf infection could create large amounts of overwintering scab inoculum and heavy ascospore release the following year.

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Apple Scab Management with Fungicides

Fungicides are used to control scab in most commercial orchards. Table 7–10, *Characteristics of Apple Scab Fungicides*, on page 81, outlines registered fungicides and their efficacy on scab and other apple diseases.

Here are some definitions of fungicide activity.

- **Protective activity** — the ability of fungicide residues to inactivate and kill fungal spores, preventing infection.
- **Presymptomatic (after–infection) activity** — fungicide that prevents scab lesions from developing once the infection has occurred, when it is applied within the period given in Table 7–10.
- **Post–symptomatic (curative) activity** — fungicide's ability to prevent or greatly inhibit the further production of secondary spores (conidia) when applied to sporulating secondary scab lesions. Generally, applications of fungicides with eradicant activity must be repeated for best effect.

Early Season Management

Management programs for primary apple scab infection are based on the timing and type of fungicide being used. There are 2 general approaches.

Protectant Fungicide Program

Fungicides are applied to expanding foliage before infection periods occur. Begin the program just before the first anticipated primary infection period (between silver tip and green tip). Apply fungicides when infections are imminent, preferably just before each expected primary infection period.

- The exception to this is when using sterol-inhibiting fungicides. Use a 7–10 day spray schedule regardless of rainfall.
- From first cover until early August, apply fungicides at 10–14 day intervals depending on rainfall frequency. New growth and expanding fruit must be protected and residues that have been washed off by rain must be replaced.
- Some fungicides are not readily washed off and the residues are redistributed by rainwater. (See Table 7–10, *Characteristics of Apple Scab Fungicides*, on page 81.)

Presymptomatic (After-Infection) Sprays

An after-infection spray is one applied within a specific time after the start of an infection period. The time available to apply the fungicide effectively depends on the product used and the average temperature. (See Table 7–10.) When calculating after-infection activity, you must start counting the time interval from the beginning of the infection period. For example, at 6°C you would have to apply captan within 48 hr from the beginning of the infection period.

- Do not rely on presymptomatic (after-infection) fungicide programs to control scab. In order to use this type of spray program successfully, equipment capable of providing good spray coverage under adverse conditions is necessary. Reliable and accurate temperature and leaf wetness monitoring equipment for each orchard is essential.
- After-infection sprays are usually considered emergency treatments. Use only if the regular protectant program has been weak or ineffective, and/or scab is present on the trees. After-infection sprays are sometimes used effectively in processing and juice blocks.

Use of Sterol-Inhibiting Fungicides

Nova 40 W and Nustar are members of the sterol inhibitor (SI) group of fungicides. These products must be used differently than protectant fungicides such as captan or mancozeb.

The main strength of the SI group of fungicides is their relatively long postinfection, presymptom activity. The SI's can cure new scab infections if applied within 72–96 hr after infection. The SI fungicides, however, generally have only 3–5 days of protective ability.

SI fungicides are systemic and must be absorbed by the leaf and fruit tissue to be effective. SI's will be absorbed within 1hr of application and effectiveness will not be reduced if rain occurs more than 1 hr after application.

SI fungicides do not redistribute well after application. Therefore, uniform spray coverage is essential for good disease control.

Apply Nova 40 W or Nustar plus a protectant fungicide (e.g. captan) within 72–96 hr following the beginning of the first scab infection period recorded near tight cluster. Apply follow-up sprays of Nova 40 W or Nustar, plus a protectant fungicide, consecutively at 7–10 day intervals. Do not stretch consecutive applications past 10 days. Apply at least 2, but no more than 4 sprays/season, preferably between tight cluster and first summer spray. Follow up with a protectant fungicide program as required after the last Nova 40 W or Nustar application.

After the last Nova 40 W or Nustar plus a protectant fungicide application, apply a protectant fungicide before the next scab infection period, but not within 5 days of the Nova 40 W or Nustar plus protectant fungicide application. Resistance has developed to the SI fungicides in other countries, where multiple applications were made each season for several years. To minimize or delay the development of SI-resistant apple scab in Ontario orchards, mix Nova 40 W or Nustar with a protectant fungicide (e.g., mancozeb or captan). Limit the number of applications to no more than 4/season. Do not use Nova 40 W or Nustar when scab lesions are present, because this may encourage the development of SI resistant strains of scab. Alternating between Nova 40 W and Nustar is not recommended since they have similar modes of action.

Do not apply sterol–inhibiting fungicides when scab lesions are present because this encourages resistance to develop.

Strobilurins

Sovran is a member of a new family of fungicides called Strobilurins. Sovran has good protectant, post-infection and antisporulant activity on apple scab and powdery mildew. Do not use Sovran earlier than tight cluster and apply in blocks of 2 applications, 10 days apart. Due to of its mode of action, it is important to follow resistance management strategies carefully. Use another chemical family for 2 applications before returning to Sovran. After the last application of Sovran tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Sovran is phytotoxic to some varieties of sweet cherries.

Control Under Adverse Weather Conditions

Several consecutive days of continuous wet conditions and mild temperatures are common in the spring. These conditions are favourable for the development of apple scab infection. It is often difficult to maintain sufficient fungicide on the trees to provide protection

TABLE 7–10. Characteristics of Apple Scab Fungicides

Product/1,000L	Protectant Activity (Preinfection)	Max. After-infection[1] Activity (hr)			Post-symptom Activity	Retention (50 mm rain)	Re-distribution (12 mm rain)
		6°C	12°C	17°C			
Benlate 50 WP (0.5 kg)	F	48	24	18	VG	G	P
Captan 50 WP (2 kg)	VG	48	24	18	N	VG	G
Dikar WP (2 kg)	VG?	48	24	18	VG	E?	VG?
Dithane M 45/80 WP (2 kg)	VG	48	24	18	N	E	VG
Equal 65 WP (0.5 kg)	VG	48	24	18	VG	VG	VG
Manzate 200 (2 kg)	VG	48	24	18	N	E?	VG
Nova 40 W (140 g)[2]	F	96	96	96	FG	F?	F?
Polyram 80 WP (2 kg)	VG	48	24	18	N	E?	VG
Nustar	F	96	96	96	E	E	
Sovran	E	96[3]	96[3]	96[3]	E	E	F?

Data is adapted from New York (Geneva) from work done by Szkolink et al. using conidia. These values are adapted from greenhouse tests on Golden Delicious. Rate/ha is 3 times rate/1,000 L. The after-infection activity of these fungicides may not be adequate to control primary scab in commercial orchards. Do not rely solely on after-infection activity for the control of apple scab.

These results are formulation specific. Newer formulations of some products have not been evaluated (e.g., Dithane DG, Polyram DF, Manzate 200DF). Contact the manufacturer for more information.

[1] Maximum after-infection activity is calculated from the start of the infection period.

[2] Data on Nova is adapted from *1993 Pest Management Recommendations for Commercial Tree Fruit Production*, Cornell Cooperative Extension, New York.

[3] After-infection activity may be reduced in orchards where scab populations have shifted toward DMI fungicides (Nova, Nustar).

KEY: E = excellent; VG = very good; G = good; F = fair; P = poor; N = none. Values followed by (?) are based on field observations.

for the rapidly-expanding foliage and fruit under such conditions.

If you feel your trees are not protected, it is better to apply a protectant-type fungicide during a break in the rain, than to not spray at all. Be sure to use a fungicide with good retention properties. For example, Mancozeb has good retention activity, while Benlate has poor retention when applied to wet trees. (See Table 7–10.)

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit. Benlate has anti-sporulant activity beyond the stated after-infection activity period when resistance is not present. Repeat application in 4 or 5 days if wet weather persists.

If an infection has occurred, scab lesions become visible on the foliage and fruit in about 9 days at 20°C or in about 14–21 days if the average temperatures are 12°C or lower.

Control these infections as soon as they become visible by following the instructions outlined in the section below on *Deactivation of Established Scab Lesions.*

Strong winds can hamper spraying operations by causing pesticides to drift away from the intended target. Spray at night or early morning to help reduce spray drift. Lowering the spray trajectory into the wind may also help, but take extra care to make sure that the treetops get good spray coverage.

Deactivation of Established Scab Lesions

Apple scab lesions that are visible on the foliage and fruit can produce many spores capable of spreading the disease through secondary infection. Several fungicides have good post-symptomatic activity. (See Table 7–10.) However, benomyl (Benlate), thiophanate-methyl (Senator) and dodine (Equal) have not been effective where resistance to these fungicides is present. Resistance to these fungicides is widespread in Ontario apple orchards.

If fungicide-resistant scab is not present in your orchard and apple scab lesions are visible, you can try to deactivate these tissue infections. Apply 2 sprays of a post-symptomatic fungicide at the full rate 5–7 days apart as soon as scab lesions are observed. These materials reduce the number of spores produced on the lesions and help to slow the spread of the disease. Follow with a regular season-long protectant program.

Secondary Scab Management

The end of primary season can be determined by using the degree-day model. At 418 DDC, over 95% of the ascospores are mature, and after a significant rain event all of the ascospores have been discharged for the season. (See Table 7–7 on page 77.) After this point, wait 2 weeks before checking your trees to see if scab is present. It can take up to 14 days for lesions to appear following a scab infection period. Be sure to check in the top of standard trees or anywhere else where you feel that spray coverage may not have been adequate, e.g., thick tree canopy.

If primary scab has been controlled in your orchard, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season. Some growers have successfully eliminated all use of fungicides during the summer months where primary scab was avoided. If scab lesions are found, maintain a fungicide program for the remainder of the season.

Fire Blight of Apple

Fire blight can be a major disease problem for Ontario growers. The following practices, used together, can help reduce blossom and shoot blight infection in susceptible cultivars. For detailed information on biology and management of fire blight, see OMAFRA Publication 310, *Integrated Pest Management for Ontario Apple Orchards.*

Predicting Fire Blight Infections

Maryblyt is a computer modelling program designed to predict fire blight infections. Maryblyt uses daily minimum and maximum temperatures such as rainfall amounts and wetness (from heavy dew) and weather forecasts to predict the potential of fire blight infection. Advanced warning (1–4 days) of fire blight infection is provided during the critical susceptible growth stages. The most precise prediction for your farm can be obtained by using your own data with Maryblyt. Copies are available from Gary Lightner, 293 Tuscawilla Hills, Charles Town, WV 25414, phone: 540-869-8372, e-mail: gary_lightner@hotmail.com or gary.lightner@fishersci.com.

Cultural Practices

- Make use of tissue and soil analysis to avoid applying excessive amounts of nitrogen fertilizer in the spring. Succulent, rapidly growing shoots and suckers are more susceptible to fire blight infection.

- Remove all diseased wood during the dormant season, (Jan. or Feb.) when temperatures are below freezing. Patrol orchards at least twice/week when blossom and shoot blight symptoms are predicted to occur. It is practical to remove these new infections from the orchard when the number of strikes is low to avoid further spread of the disease.

- New infections must be pruned at least 30–45 cm below discoloured wood using pruning tools. During growing season leave a stub of wood 2 yr old or older, and then prune this stub out during the dormant period. Leaving a stub allows the fire blight to form a localized canker, which the tree can seal off, preventing the infection from extending further into a main limb.

- Disinfect pruning tools with household bleach (6% sodium hypochlorite solution) by mixing 1 part household bleach in 4 parts water. Store bleach solution in a well-labelled closed plastic or glass container. Wash tools after use and apply oil to prevent rust. Denatured alcohol (ethanol) is a better disinfectant than the bleach solution and does not rust tools.

- In intensively managed orchards, it may be practical to remove secondary blossoms on apple cultivars such as Golden Delicious and Paulared before they become infected.

Chemical Control

- In spring, warm temperatures (18°C or greater) and moisture (rain, or heavy dew) favour infection of blossoms. When these conditions are predicted, and they persist through the blossom period, protect the blossoms with Streptomycin 17 at 100 ppm (100 ppm = 600 g product/1,000 L).

- Spray during slow drying conditions. Spray is most effective when applied dilute (high volumes of water) prior to a wetting period. For best results use Streptomycin 17 alone in the tank.

F2

- Because it is sensitive to ultraviolet light, Streptomycin 17 is effective for only 2–3 days. Re-application is also needed to protect newly opened blossoms, after 2–3 days, if warm, wet conditions (above 18°C) prevail. Two–4 sprays during the bloom period may be necessary to protect blossoms against fire blight infection.

- In non-bearing orchards, copper sprays may be substituted for Streptomycin 17. However, copper sprays are less effective than Streptomycin 17 for controlling fire blight. Mix copper sprays with lime according to label directions. For more information on registered formulations, rates and mixing instructions see *Use of Copper Products on Fruit Crops* on page 51.

- If hail or damaging winds occur during the growing season, apply Streptomycin 17 within 12 hr to prevent trauma blight causing serious damage to the trees and crop. Beyond 24 hr streptomycin is not effective. Ensure a 50 day-to-harvest interval on apple.

Excessive use of Streptomycin 17 may lead to the development of fire blight resistance.

For best results, use all cultural and chemical control methods together to keep fire blight at a manageable level in the orchard.

Phytophthora Collar Rot Control

Collar rot occurs where trees are planted in heavy soil, poorly drained soils, or replanted in old orchard sites. This disease, caused by a long-lived, soil-borne fungus *Phytophthora cactorum*, is especially damaging to apple trees grown on MM.106 rootstock. Trees on M.26 and M.111 rootstocks are intermediate in susceptibility, while M.7A and M.9 rootstocks are moderately resistant.

Where concern for collar rot is present before planting, do not plant susceptible rootstocks.

For problem areas, Ridomil Gold 480 EC is registered for use on non-bearing trees only. Apply Ridomil Gold 480 EC as a drench to the soil around the base of the tree. Use 1 mL in 5 L of water/tree. Make the first application at planting and repeat in late Aug. In subsequent non-bearing years, apply Ridomil Gold 480 EC in the early spring and again in late Aug. This treatment will suppress fungal growth and development. However, the fungus will survive in the soil. Long-term control should include resistant rootstocks and proper site selection.

Blue Mould and Grey Mould in Stored Apples

Under certain conditions rot can develop on apples during storage. Disease organisms are common in and around grading lines, work areas and storages. Fungi causing blue mould *(Penicillium)* and grey mould *(Botrytis)* are spread in air currents and by water.

Infection of apples most commonly occurs after harvest through stem punctures, wounds, skin breaks and heavy bruises. These fungi can be transferred from contaminated bins, water used for dipping or drenching, and grading equipment.

Rot develops faster if the infected apples are:

- delayed going into storage
- cooled slowly in storage
- stored for a longer period, or
- held at warm temperatures after removal from storage.

Reducing Disease Development

Careful handling during and after harvest to minimize stem punctures, skin breaks and bruising can greatly reduce the number of infection sites on the fruit.

At the storage, life-truck operators must move the bins with a minimum of jolting and dropping. Refrigerate the fruit as quickly as possible. Adequate refrigeration capacity for each storage room is required. Modern refrigeration facilities and controlled atmospheres also reduce fruit rot.

Sanitation in the handling/grading area is most important. Careful removal of rotted fruit from the premises, and disposal off the property, greatly reduce the dispersal and spread of disease organisms within the building.

TABLE 7–11. Effect of Fungicides on Apple Diseases*

Fungicides	Apple Scab	Powdery Mildew	CedarApple Rust/Quince Rust	Black Rot	Bitter Rot	Sooty Blotch	Fly Speck
benomyl (Benlate)	++R	+R	0	+++	++	+++	+++
captan (Captan, Maestro)	+++	0	0	+++	++	+++	++
copper	+	+	+	+	+	+P	+P
cyprodinil (Vangard)	++	+	0	0	NA	0	0
dithane+ karathane (Dikar)	+++	+++	++	+	NA	+++	+++
flusilazole (Nustar)	+++	++	+++	0	0	0	0
kresoxim-methyl (Sovran)	+++	++	+	+++	++	+++	+++
mancozeb (Dithane, Manzate, Penncozeb)	+++	0	++	0	NA	+++	+++
metiram (Polyram)	+++	0	++	0	NA	+++	+++
myclobutanil (Nova)	++	+++	+++	+	0	0	0
sulfur	+	++	+	0	0	0	+

R = Pathogen resistance (insensitivity) present to the fungicide. P = Phytotoxic, causes russetting. 0 = no control. NA = not applicable because the fungicide cannot be applied during late summer when bitter rot infections usually occur.

+ = poor to fair control, ++ = good control, some limitations, +++ = excellent control, few if any limitations, ? = efficacy unknown.

This table was developed by the IR4 Project through discussion at the annual meeting of the Deciduous Tree Fruit Diseases Workers in August, 1999 and updated after conversations with various researchers in the Northeast US and Canada.

*** Use fungicides only for control of diseases listed on the product label.**

Frequent changing of the water used for dipping or drenching reduces the accumulation of fungal spores in the water, greatly reducing the risk of fruit infection.

Postharvest Treatment

Thiabendazole (TBZ) can reduce disease incidence. A formulation called Mertect SC is registered in Ontario to control the development of *Penicillium spp* (e.g. blue mould) and *Botrytis cinerea* (e.g. grey mould) on stored apples and pears. Mertect SC can be used as a postharvest dip or drench. The rate is 0.5 L of product in 500 L of water. Certain precautions must be followed.

- Constant agitation is required to maintain a suspension during treatment.
- Mertect must be in direct contact with the skin of the fruit. Do not apply wax prior to Mertect treatment.
- Consult the label for additional instructions.

Research and field experience indicate that resistant strains of these diseases are common. Resistant strains are not controlled by treatment with thiabendazole. However, the addition of diphenylamine (DPA) to reduce superficial scald in the postharvest treatment is reported to control some resistant strains of blue mould (*Penicillium*) and grey mould (*Botrytis*).

Apple Insect Control

Obliquebanded Leafroller

Obliquebanded leafroller (OBLR) is a direct pest of apples. In most commercial orchards OBLR populations are resistant to organophosphate insecticides. Resistance to pyrethroids and Confirm has also been documented in some populations. In orchards where pesticide resistance is suspected, the use of insecticides to control OBLR should be restricted to *Bacillus thuringiensis* (*B.t.*) (Dipel, Foray or Bioprotect), or the naturolyte insecticide "Success".

Success (spinosad) is a new insecticide for control of obliquebanded leafroller. It has a unique mode of action that affects the insect nervous system.

Success and *B.t.* products must be ingested to be effective. Apply when larvae are actively feeding and when temperatures are above 10°C. For resistance management reasons, rotate insecticides between generations, not within generations.

There are 2 generations of OBLR in Ontario. Monitor the larval activity of the OBLR in the orchard to determine when this pest is active.

- Overwintering 2nd or 3rd instar larvae become active and begin feeding on developing green tissue from pink to petal fall. Apply pest control products when actively feeding larvae are detected in terminal growth.

- For the subsequent summer generation, monitor adult activity using pheromone traps (placed in the orchard by mid-June). Timing of insecticide application for controlling the summer generation is for first egg hatch (late June–early July). This event occurs at 200–220 degree-days Celsius after the biofix of first sustained moth catch. Both Success and *B.t.* products have a short residual activity, and as a result it is important to apply subsequent sprays, to control the extended emergence of the small larvae.

Maintaining the proper pH in the spray solution is important for both *Bacillus thuringiensis* and Success. The spray solution for *B.t.* products should be at pH of 7 or less, while that of Success should be at a pH of 6 or more.

Oriental Fruit Moth

Oriental fruit moth (OFM) is a new and emerging pest in Ontario apples. The OFM is now established in 3 of the 5 major apple-growing regions in the province (Niagara, Essex/Kent, and Norfolk).

The adult OFM is a small, dark grey moth (8–10 mm long), with wavy, light grey bands. Mature larvae have a brown head capsule and a distinct pink body.

The larva attacks young terminals and fruit. Infested shoots wilt, developing a condition called "flagging". Although flagging damage is obvious in peach trees, it is less so in apples. Some apple varieties appear to be more susceptible than others to twig infestations.

1st and 2nd generation larvae attack terminals, and then move to fruitlets approximately 7 days later. Subsequent generations (3rd and 4th) complete their larval development in the fruit. Larvae burrow into the fruit leaving frass on the surface of the apple. It is easy to mistake OFM damage for codling moth damage.

- OFM typically enter the fruit from the calyx and move in towards the core very quickly.

- If the fruit is very hard and small, the OFM larvae tend to feed near the surface of the skin.

- Codling moth will feed a little at the surface of the fruit before moving inside, and as a result their entry holes are slightly larger than those of OFM.

- OFM leave separate entrance and exit holes in peach, while in apple they generally leave the fruit from the same hole they entered.

- Fruit infested early in the season will often drop preharvest.

- Later season OFM damage can be very inconspicuous, since the larvae often enter the apple near the stem, leaving no obvious sign of entry.

Emergence, flight and peak activity of OFM moths are monitored using pheromone traps. Sources of infestation include non-maintained peach trees, fruit containers and packing barns.

In November 2001, a product for mating disruption of OFM was registered in Ontario. Isomate M100 was granted temporary registration on stone fruit, apple and pear. The product is a pheromone, formulated in twist ties. Other products, including sprayable pheromone formulations, may soon be available. Mating disruption technology is used in grapes (see *Mating Disruption Technology (MD) for Grape Berry Moth* on page 140) and research has shown it can be extremely effective in controlling OFM in peaches. It has not been evaluated in Ontario apple production systems.

Mating disruption is pest-specific, and has low-toxicity to workers and beneficial organisms. Use of this technology requires specific knowledge and management practices. Extensive monitoring throughout the season for OFM and secondary pests is necessary. Recommendations for mating disruption on apples were not available when this document was printed. For more information on mating disruption, call the OMAFRA Agricultural Information Contact Centre, 1-877-424-1300.

Thinning and Growth Regulators

Chemical Thinning of Apples

Thinning of apples is required to improve overall fruit size and finish, create more uniformity in the crop and to encourage return bloom. The sooner you accomplish thinning after the bloom to fruit set period, the greater the potential for increasing fruit size. The objective is to reduce clusters to single fruitlets (preferably king bloom fruitlet). Thinning needs are based on grower experience, taking into account the cultivars involved, fruit sizes required, strength of bloom, bee activity and weather conditions during pollination. The previous thinning history should be well documented. A well-thinned crop has better colour and picks more easily at harvest.

Chemicals Available for Thinning

Accel

Accel is an altered form of Promalin containing the growth regulator benzyladenine (BA), which is the active ingredient for thinning, and gibberellin A4+7. Accel is registered for use in Canada at the rate of 2.5–4.0 L/ha, which is equivalent to 49–74 g BA/ha. The use of Accel is limited to 2 sprays, each containing no more than 74 g BA/ha. Since the label is based on a per hectare basis, the maximum concentration applied depends upon the tree size and volume of water used to obtain good coverage. Research at the Simcoe Horticultural Experiment Station and elsewhere indicates that the concentration of BA in the spray solution is also important. Concentrations below 50 ppm BA are generally ineffective for thinning or improving fruit size.

Accel is not a satisfactory thinning compound for all cultivars but has exhibited effectiveness for Empire, McIntosh, Idared, Gala and others. See Table 7–14, *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 93.

Unlike other chemical thinners currently available in Canada (NAA and carbaryl), Accel has the potential to improve fruit size independent of thinning. This is accomplished by increasing cell division shortly after flowering during the early stages of fruit growth and development that may translate into larger fruit at harvest.

The window of best response for Accel is between 5–12 mm fruitlet size.

Dilute Accel in 500–1,000 L of spray solution/ha. Uniform and thorough coverage is essential.

Environmental Conditions

To optimize plant uptake of the spray solution, apply Accel during periods of slow drying (for example, early morning). Best results are obtained when warm temperatures (greater than 20°C) occur during and following application. Always read the label before using.

Spray Concentration

After determining the concentration of BA to use, it is important to then determine the water volume required to wet the foliage just to the point of runoff. After this has been determined use Table 7–12, *Accel Rate*, page 87, to determine the volume of Accel to add to deliver the correct amount of BA in the correct concentration to be effective.

NAD (Naphthaleneacetamide)

NAD, such as AMID THIN, is a hormone-type material that is absorbed by foliage, where it induces formation of the abscission layer between the spur and the fruitlet. NAD is a relatively safe material that is applied at first petal fall; i.e. petals on the king blossom are falling. The concentration will vary from 50–100 ppm, depending on variety and growing conditions. Used at the proper timing it is particularly effective on hard to thin varieties such as Golden Delicious. This hormone-type material is mostly absorbed from the original solution. Once dry, the effect it has on thinning is over. Therefore large water volumes applied under slow drying conditions are recommended. Weather that promotes soft, succulent and rapid growth will lead to increased absorption. Avoid windy, cool, fast drying conditions. Temperatures between 21°C–24°C are considered optimum.

NAA (Naphthaleneacetic acid)

NAA such as FRUITONE-N, is a hormone-type thinner that is absorbed primarily through the leaves. It works as a growth regulator affecting auxin activity and interfering with proper fruit development by accelerating ethylene biosynthesis. The fruitlet being thinned usually drops within 10–14 days after spraying. NAA needs to be dissolved in water in order to be absorbed by the foliage. Almost all NAA is absorbed from the original solution. Once dry, the thinning effect is stopped. Thus, larger volumes of water used under slow drying conditions are recommended when applying NAA. The longer the time required to dry the spray and the higher the drying temperatures, the greater the absorption of the NAA. NAA also has a short life due to breakdown by sunlight. The most effective time to apply is under warm, dull, slow drying conditions. The preferred time is in the morning when the trees are damp, drying is slow, and the temperature is on the rise. The material is absorbed and the tree has an immediate growing day to use the thinner NAA is considered to be rain fast after 2–3 hr NAA is not effective at temperatures less than 10°C. NAA can result in leaf flagging (wilting) but these leaves recover in a few days.

Precautions

Do not apply Accel in combination with the hormone thinners NAA (Naphthaleneacetic acid) or NAD (Naphthaleneacetamide) either as a tank-mix or separate sprays during the same growing season, as this may result in the formation of pygmy fruit.

TABLE 7–12. Accel Rate

The relationship between spray water volumes required to thoroughly wet trees, grams active ingredient (BA) per hectare, and concentration of BA and per hectare rate of Accel.

Spray Volume required to thoroughly wet trees (litres/ha)	grams BA per hectare				
	25	37	49	62	74
	litres of Accel per hectare				
	1.3	2.0	2.6	3.3	3.9
	Concentration of BA in parts per million (ppm)				
200	124	185	247	309	371
300	82	124	165	206	247
400	62	93	124	154	185
500	49	74	99	124	148
600	41	62	82	103	124
700	35	53	71	88	106
800	31	46	62	77	93
900	27	41	55	69	82
1,000	25	37	49	62	74

Concentrations of BA in shaded area not recommended.

Carbaryl (Sevin)

In the early 60's the insecticide "Sevin" with the active ingredient carbaryl was discovered to have fruit thinning properties. Carbaryl is absorbed primarily through the fruit, not the foliage. The presence of carbaryl in the vascular system of the fruitlet interferes with biochemical processes. Certain important fruit growth processes cease, and the fruitlet drops. This fruitlet drop usually starts 5–10 days after application. Thinning with Sevin increases regularly with concentrations up to 1.0 kg active carbaryl (2.0 L Sevin XLR Plus)/1,000 L of water. There may be little or no increase in thinning with higher concentrations. Carbaryl is relatively insoluble in water and low concentrations produce a saturated solution. This insolubility is a limiting factor in its effectiveness because absorption by the fruitlet is limited to materials in true solution. It is an advantage however, in that the hazard of over thinning, through error in concentration, is reduced. Surface residues of the XLR Plus formulation of Sevin (unlike the 50W formulation) do not provide additional thinning effects when rain or dews cause rewetting of the tree canopy. Sevin, although the easiest and safest thinner to use, can be harsh on beneficial insects and mite predators, if present, depending on amounts used.

1 L of Sevin XLR Plus contains approximately the same amount of active ingredient (carbaryl) as 1 kg of Sevin 50 W.

Carbaryl (Sevin) plus NAA

This combination has been used on hard-to-thin cultivars such as Paulared, Golden Delicious, Fuji and Gala strains, with considerable success. Use a constant rate of 1 L Sevin XLR Plus (product)/1,000 L of water with varying rates of NAA from 3–15 ppm. Because NAA only has 1 chance to work, higher water volumes are recommended.

Length of Wetting Period and Temperature for Material Absorption

Uptake of thinning materials is faster at higher temperatures than lower ones. Best temperatures for absorption are in the 20°C–25°C range. At these temperatures, drying time of the canopy is usually much faster than the drying time when temperatures are 10°C–15°C cooler as characteristic of early morning or evening spraying. The absorption rate under cooler conditions appears to be slower and stretches over a longer period or until the canopy dries.

The total amount of thinning chemical being absorbed by the canopy appears to be more or less equal under both sets of conditions regardless of drying time (warm and fast or cool and slower). Based on these facts, growers should be less concerned about time of day that the materials are applied from a drying perspective. Recent research results on selected cultivars indicate no differences in success based on timing of sprays during the day or night. One advantage of spraying in early morning or evening is the reduced likelihood of blowing thinners off target, as wind can become more of a factor during the day.

Factors Influencing Response to Thinning Agents

Cultivar Sensitivity (Mature Trees)

Easy-to-thin cultivars include non-spur Red Delicious, Idared, Crispin (Mutsu), Jonagold strains, Jerseymac, Honeycrisp.

Moderately difficult cultivars include Empire, McIntosh, Northern Spy, Cortland, and Gingergold.

Harder-to-thin cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

Weather Conditions

Certain weather conditions may increase the thinning response by permitting greater absorption of chemicals:

- cool, wet weather and low-light conditions before or after application
- prolonged period of high humidity without rain either before or after application
- high temperatures following cool periods
- frost or near-freezing temperatures before or shortly after application
- a prolonged period of dry weather before application.

A decrease in thinning response can result from the following condition, which results in a high net accumulation of carbohydrate reserves in the tree:

- sunny and warm daytime temperatures accompanied by relatively cool nighttime temperatures before and after thinning treatments have been applied.

Pollination and Bee Activity

These activities are tied in closely with weather conditions. Pollinating conditions and bee populations may render fruit either more or less difficult to thin. Fruit set under good pollinating conditions, resulting in increased seed count, is harder to thin. Fruit set on king blossoms is more difficult to thin than fruit set on side blossoms. Single fruit are more difficult to thin than clustered fruit. A light or spotty set, with clustered fruit, should be thinned but at low rates in order to break up the clusters.

Tree Age and Vigour

- Young trees are more easily thinned than mature trees that have cropped well for 2–3 yr. Hand-thin young trees of high-value cultivars that do not have a settled cropping pattern. Low rates of thinners that work on mature trees can easily over-thin young trees.

- Mature trees that are low in vigour, for whatever reason, are more easily thinned.

- Trees bearing a heavy crop one year with good bloom the following year may be more easily thinned.

- The heavier the bloom, the more stress on the tree, and the easier to thin.

- The more stress from the previous season, e.g. excessively dry or excessively wet, nutritional deficiencies, insects or disease, then the easier to thin.

Density of Foliage

- Poorly-pruned dense trees are thinned more easily than well-pruned open trees.

- Lower, partially shaded, branches of well-pruned trees are thinned more easily than upper branches because of weaker spurs.

- Water volumes may have to be increased if thinning is delayed significantly to ensure adequate coverage of a rapidly developing tree canopy and leaf surface area during the fruit set period.

Timing of Application

Application timing varies with the chemical used. Apply NAD during early petal fall (see NAD section above). The best timing for application of NAA, Sevin, and NAA + Sevin combinations is usually 7–12 days after petal fall[1]. (Early cultivars are an exception, see Table 7–14, *Suggested Rates for Chemical Thinning of Mature Apple Trees*, on page 93.) Use 7 days if it is warm and 12 days if it is cool. Sevin can be effective as a thinner when applied up to 21 days after petal fall. NAA is only effective as a thinner if applied up to 12 days after petal fall. NAA applied too soon (bloom to petal fall period) can result in excessive thinning of Empire. This early application of NAA on Empire also stops fruitlet growth for several days, resulting in reduced fruit size at harvest when compared to a King diameter timing around 10 mm. NAA applied too late can result in reduced fruit size and, in severe circumstances, pygmy fruit.

For some cultivars, a size relationship for applying chemical thinners based on the average fruitlet diameter has been established. See Table 7–13, *Suggested Timing of Thinning (NAA)*. When the largest fruitlets (preferably the king bloom fruitlet) have reached the diameter stated, the fruitlets that are smaller and weaker should drop off if the thinner is effective. This relationship works best when the king bloom fruitlet is larger than the side bloom fruitlets and when the size and stage of development of all the fruit to be thinned is fairly uniform.

TABLE 7–13. Suggested Timing of Thinning (NAA)

Cultivar	Diameter of largest fruitlets in cluster
McIntosh	8.0–9.5 mm
Red Delicious	6.5–8.0 mm
Northern Spy	10.0–11.0 mm
Empire, Idared, Jonagold	8.0–10.0 mm
Gala, Golden Delicious, Fuji	8.0–9.0 mm

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[1] Petal fall — when 80% of the petals have fallen off but before calyx lobes are closed.

Sampling Method

A total of 50–60 fruitlets of each cultivar should provide a good estimate of fruit development in a reasonably uniform orchard block. Select the 2 largest developing fruits from each of 25–30 randomly selected clusters. Measure the greatest diameter of each and determine the average for the sample. Vernier calipers or a thinning template provide a simple means for taking measurements rapidly and accurately.

Steps in Thinning

1. Determine how much thinning is required by looking at the orchard factors and assessing fruit load potential. Sepals (calyx leaves) on unpollinated bloom tend to stay open or bend back. Successful pollination and fruit set results in sepal movement and closure.

2. Determine the material to use and the concentration or strength of the thinner required.

3. Determine the water volume required to effectively wet the trees. Dilute water volumes are recommended when applying chemical thinners. In single row orchards, as the tree size becomes small and the number of trees/ha increases, the volume of canopy that must be sprayed may become less. The average tree on M26 (3–3.5 m tall) at a density of 720 trees/ha (300/ac) may require more than 2 L of spray/tree to thoroughly wet it at the time of thinning. The "tree row volume" concept of calculating dilute water volumes is an accepted way to calculate required volumes. See OMAFRA Factsheet, *Guide for Spraying Tree Fruits*, Order No. 93–121. Some calibration work may have to be done on small groups of trees to determine just how much volume is required to thoroughly wet individual trees.

BEE WARNING

When Sevin is used in fruit thinning, extensive bee kills can occur if weeds or legumes are blooming in the ground cover. To reduce the chance of poisoning, remove bees from the orchard prior to treatment. Do not spray when the wind will carry Sevin to adjacent weedy or crop areas in bloom. Sevin XLR Plus is much safer to use than Sevin 50 W around honeybees. Advise local beekeepers of your spraying activity.

Special Conditions

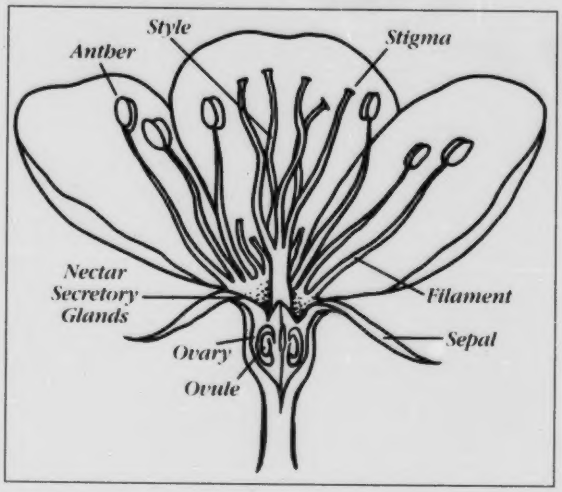
Thinning after a badly-frosted bloom

Depending on the severity of the damage, growers may decide to thin sections or areas of blocks that appear to have escaped the worst of the frost damage. Due to differences in elevation and airflow in the orchard, trees on lower ground can easily be subject to 2°C–3°C colder air than trees on higher ground from the same frost event in the same block.

This results in a great variation in damage to tree foliage and the potential fruit set. In making a decision to apply thinners, the grower may plan to go through the block anyway because of what appears to be a fairly normal set on trees on higher ground. Nozzles can be shut off in areas of the block that are showing significant potential losses in crop load from frost. Likewise nozzles directing thinning sprays into the lower canopy area can be shut off if necessary.

Carefully evaluate damage to the bloom. Petals, stamens, pistils and ovaries can exhibit a significant difference in their response to freezing temperatures. (See Figure 7–3, *Anatomy of an Apple Bloom*, on page 91.) Although flower petals are browned off by frost the process of set can still take place from pollen deposition that occurred 1–2 days previous to the frost event. Frost events around bloom usually produce a variety of symptoms, including bands of russetting that run either around the fruitlet (frost rings) or lengthwise from the stem to the calyx and can also influence seed count to produce a high proportion of misshapen fruit at harvest. Extreme caution is advised when thinning on top of a significant frost event. Leaves damaged by frost are more absorbent of thinners. Fruitlets with reduced seed count abscise more easily. Lower rates of thinner are justified for many varieties under these circumstances. The grower may choose to stay away from a badly damaged block and rely on hand thinning if necessary. A light amount of frost damage should not prevent a grower from using thinning treatments that have worked in the past for any given cultivar.

FIGURE 7–3. Anatomy of an Apple Bloom



Thinning when the king bloom is lost to frost

Response to thinning treatments is generally based on size and dominance differences within the cluster of set fruitlets. The king fruitlet of most cultivars is usually larger, stronger and more dominant than side-bloom fruitlets. (An exception is Paulared). The king will normally hold on when weaker, smaller fruitlets drop in response to treatments.

If the king bloom or king fruitlet is lost to frost, size and strength differences amongst remaining fruitlets can be minimal, making them equally weak and vulnerable to thinners. The best approach in this case may be to wait until size differences show up in the cluster (provided the largest fruitlet is not greater than 12–14 mm). These size differences may become more apparent several days past full bloom. A difference of few hours in pollination timing can show up in size differences of side-bloom fruitlets as the post-bloom period progresses.

Thinning when weather conditions are exceptionally unfriendly

Weather conditions are often not suitable for application of thinners even though the fruitlet diameter is at the recommended stage of development. Poor conditions can include cold, wet, windy or rainy weather that can persist for a days at a time. Growers are better off waiting for warmer temperatures, more sunlight and less wind, even though the fruitlet diameter could be larger than the suggested timing diameter.Timing when king fruitlets are at 12–14 mm diameter will give a better response to thinning treatments under warmer conditions than a timing of 8–10 mm king fruitlets under persistent cold wet and rainy conditions. Warmer temperatures include temperatures at or above 18°C during the day of application or for 24 hr after spraying.

Thinning an unevenly set crop

An unevenly set crop should, in most cases, still have a thinning program applied to it. Single fruitlets are much tougher to remove from the canopy. These fruitlets can be present at the same time as multiple set clusters in the same tree, or from tree to tree. In comparison, fruitlets found in clusters of 3–5 are easier to thin because of competition within the group. These clusters are easier to thin than single fruitlets on spurs in the same tree. Ultimately, only 5%–10% of the bloom in any cultivar has to be finished to produce a commercial crop of fruit. Therefore in situations of uneven set on unstressed trees and in the absence of frost injury, consider recommended thinning treatments.

Cultivar Notes

Empire

Some growers are experimenting with applying NAA during the bloom period. Before applying NAA at this time, make sure the king bloom fruitlet is set. Check sepal posture. Petal fall of king bloom can take place as early as 3–4 days past peak pollination. If NAA is used too early (full bloom to petal fall), potential overall fruit size of unthinned apples may be reduced compared to a treatment at a stage when the king fruitlet is 8–10 mm in diameter.

Gala

Gala is relatively difficult to thin successfully. On mature trees, the approach must be aggressive. Good results have been achieved using a combination of NAA and Sevin at the rates listed for Golden Delicious. Timing is suggested for king fruitlet at 8–9 mm. Overall fruit size potential is determined within 2 weeks following calyx. Clusters must be thinned to 1 fruitlet (king bloom) by mid to late June. A follow-up hand thinning within 30 days past full bloom is normally required to further reduce crop load.

Jonagold

This cultivar thins relatively easily and has good size potential when clusters are thinned to singles. Most producers get adequate thinning with moderate rates of Sevin. Overcropping of Jonagold may result in very poor return bloom and fruit may not mature to a premium quality.

Fuji

Unthinned Fuji normally returns very little bloom the following year. This cultivar exhibits strong biennial characteristics. Fuji must be thinned aggressively for best results. Mature trees usually thin adequately with combinations of Sevin and NAA. Follow-up hand thinning is usually necessary to further reduce the number of king fruitlets. Excessive crop may prevent the fruit from maturing to premium quality.

Honeycrisp

Although not fully tested for thinning response under Ontario growing conditions, this cultivar is believed to be more sensitive to thinning treatments than Empire. Thin Honeycrisp cautiously, as it can easily become oversized and is very prone to bitterpit. Use of growth regulators, which enhance fruit size, may not be warranted for this large fruited cultivar. Use no more than 2.5 ppm NAA with 1 L Sevin XLR per 1,000 L water as a starting point on established trees.

Gingergold

This relatively new cultivar appears to be in the same sensitivity class to thinners as McIntosh, Northern Spy and Empire. It can be overthinned with high rates of NAA or strong combinations of NAA and Sevin XLR or Accel plus Sevin XLR.

Calculating Parts per Million (ppm)
1 ppm = 1 g active ingredient
per 1,000 L water

Suggested Rates for Chemical Thinning of Apples

The rates in Table 7–14 are suggested guidelines only. There is no substitute for personal experience. It is important to keep yearly records on weather conditions, rates, etc., and above all, that some trees be left unsprayed to help assess the thinning response. Use only one of the suggested chemical treatments. For example, with Wealthy, apply NAD, or NAA, or Sevin, or the combination. Before altering or modifying a treatment that has proven to be effective in any situation, make sure you discuss this matter with someone knowledgeable.

Defruiting Immature Apple Trees

In some cases, it is desirable to defruit immature apple trees to encourage proper development. Experimentation to date indicates a dilute spray of NAA at 15 ppm combined with Sevin XLR Plus at 1.5–2 L/1,000 L water 5 days after petal fall, gives acceptable results. Well established, supported trees under minimal stress can carry some crop load in the second year following planting.

Key Concepts and Benefits of Hand Thinning

Hand thinning may be the only reasonable choice when dealing with immature trees that are bearing a crop of a relatively high valued cultivar. It should be done promptly following June drop.

Hand thinning:

- Helps to increase fruit size and helps and manage fruit development.
- Helps to single the fruitlets.
- Balances the number of fruiting spurs with resting spurs.
- Enhances return bloom.
- Improves crop protection because spray coverage is more uniform on unclustered fruit.
- Improves efficiency in harvest and handling of crop. Allows the tree to continue developing canopy. Helps to prevent runting.

Promalin to Improve Fruit Shape of Delicious

Promalin is a plant growth regulator used on Red Delicious apples. Promalin improves the "typiness" or shape of Red Delicious apples through elongation of the fruit and development of more prominent calyx lobes. Promalin contains a mixture of benzyladenine and 2 types of gibberellins. Careful timing of the application, close adherence to recommended label rates and complete coverage are essential for satisfactory results.

TABLE 7–14. Suggested Rates for Chemical Thinning of Mature Apple Trees[1]

(use ONE of the following:)

Cultivar	NAD ppm[2]	NAA ppm[2]	Sevin XLR[2] Plus L/1,000L	Sevin XLR Plus +NAA ppm[2] per 1,000L water	Accel (g BA/ha)[3]	Sevin XLR Plus (L/1,000L water)[2] + Accel (g BA/ha)[3]
Lodi, Melba, Quinte, Yellow Transparent	50–75	—	—	1 L + 10–15 ppm	—	—
Early McIntosh	75–100	—	—	1 L + 5–10 ppm (at petal fall)	50–75	—
Jerseymac, VistaBella, Tydeman's Red	—	5–10	1–1.5	—	—	—
Paulared	50–75	12–15	1.0–1.5	1 L + 10–15 ppm	75	1 L + 50
Spartan, Russets		10–20	1.0–2.0	1 L + 10–15 ppm	—	—
Cortland	—	5–10	—	1–2 L + 2.5–5 ppm	—	—
Non Spur McIntosh	—	5–10	1.0–2.0	—	50	—
Spur Type McIntosh	—	10–12	—	1–2 L + 2.5–5 ppm	50–75	1 L + 50
Golden Delicious, Wealthy	75–100	10–20	1.0–2.0	1 L + 5–10 ppm	75	1–2 L + 50
Red Delicious	—	2–8	0.5–1.5	—	—	—
Spur Type Red Delicious	—	5–10	—	1–2 L + 5–10 ppm	—	—
Idared	—	2–8	—	—	50	—
Empire	—	7–10	1.0–1.5	1 L + 2.5–4 ppm	50–75	1 L + 50
Spy, Crispin (Mutsu)	—	5–10	0.5–1.5	—	—	—
Jonagold	—	—	1.0–1.5	—	50–75	—
Fuji	—	—	—	1–1.5 L + 10–12 ppm	—	1–2 L + 50–75
Gala	—	10–12	—	1 L + 5–10 ppm	75	1–2 L + 50
Honeycrisp	—	5	1–1.5	1 L + 2.5 ppm	—	—
Gingergold	—	7–10	1–1.5	1 L + 2.5–5 ppm	—	1 L + 50

"—" indicates treatment recommendation not available

[1] The above rates are suggested for trees that have a settled cropping history. To chemically thin a first crop tree or trees that are considered to be immature is very risky.

[2] Sufficient water volume must be used to thoroughly wet trees. See *Steps in Thinning* on page 90.

[3] Consult Table 7–12 to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective. **1 L of Accel contains approx. 19 grams of BA.**

Note: The rates for Sevin are amounts of product. Sevin XLR Plus is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl/litre. One L of Sevin XLR Plus is roughly equivalent to 1 kg of Sevin 50 W. For actual amounts of NAD and NAA refer to the label of the product being used.

Precautions

- Applying at higher rates or volumes than those recommended on the label, or, the presence of weak or frost-injured flowers, may cause fruit thinning. Promalin usage may also increase the amount of thinning achieved with subsequent blossom thinning sprays.
- Where spur vigour is low or where the king blossoms have been damaged by frost, the fruit lengthening response to Promalin may be negligible.
- Do not apply Promalin if rain is expected within 6 hr.
- Do not apply when air temperatures are lower than 24°C (75°F) or greater than 32°C (90°F).

Application Notes

- For optimum results, apply between full king bloom and early petal fall. Applications earlier or later are likely to produce unsatisfactory response.

- High relative humidity and slow drying conditions favour maximum absorption. Preferably, apply in morning or evening.

Ethephon to Promote Fruit Colouring

Ethephon (Ethrel) has the following effects on trees and fruit, depending upon the time and rate of applications.

- Ethrel stimulates ripening, colour development, and fruit drop. The fruit may all be on the ground 1 week after spraying unless a suitable stop-drop is used. Two applications of naphthaleneacetic acid (NAA) are required: 1 as a tank-mix at the time Ethrel is applied and the second 5 days later. Apply the stop-drop at the normal rate recommended on the label.

- Spray just the number of trees that can be harvested over a 2 or 3 day period. Following the spray application the fruit will be ready to harvest within 5–10 days, depending on cultivar and air temperature. After spraying, check the maturity of the apples on a daily basis (e.g. pressure, starch, flavour, colour). A few trees sprayed at 3–4 day intervals are easier to manage than a large number sprayed at 1 time. Make sure a market is available for the treated apples before you spray, especially with early cultivars.

- Rates of application depend upon the cultivar, date of application, tree vigour, temperature, weather conditions, and degree of response required. The response to Ethrel is a chemical reaction and as such depends upon temperature. For this reason early cultivars, such as Jerseymac and Paulared, require less material than later cultivars. On early cultivars use 0.75–1.5 L of Ethrel/ha with sufficient water to wet the trees thoroughly. McIntosh requires 1.5–4.25 L/ha. Use the higher rate early in the season on trees high in nitrogen, or on poorly-pruned trees. Lower rates may be advantageous nearer the normal harvest, on young, well- pruned trees, or on trees low in nitrogen.

- Best results are obtained when Ethrel is applied 2–3 weeks before you would normally begin harvesting. Be sure and apply Ethrel uniformly, since it works only where the spray touches.

Chemical Control of Preharvest Drop of Apples

Cultivars differ in their tendency toward preharvest drop. In this respect, McIntosh gives the greatest concern in Ontario.

Fruit drop tends to be greater with trees in which the nitrogen content is high during late summer and with trees carrying a heavy crop. Hot days and warm nights just before and during harvest tend to increase the amount of preharvest drop.

Drop may also increase if trees are deficient in either moisture, or the nutrients boron or magnesium. Trees heavily infested with spotted tentiform leafminer also have a greater tendency for preharvest drop.

NAA (naphthaleneacetic acid), such as FRUITONE-N, FRUIT FIX CONCENTRATE, is registered to control drop on apples. This is the same material used earlier in the season for thinning the crop. The concentration differs for the 2 purposes. Apply NAA as soon as the first sound apples begin to drop, at the rate of 10 ppm (single strength rate). Timing is important. Do not confuse the normal preharvest drop of sound apples with those that have been pushed off, or are dropping because of insect, disease, or nutritional deficiency.

NAA is effective for 7–10 days after spraying. Longer holding can be obtained by repeated application of a single strength rate every 7 days. If applied before any harvest has taken place, it takes 1–2 days for NAA to take effect after application. If applied after the orchard has been spot picked it may take longer to take effect. Therefore, it is best to apply it as soon as you finish the spot pick. Do not apply NAA closer than 5 days before harvest. Refer to the label.

NAA is preferably applied in a dilute spray. A dilute application favours more uniform coverage, which is important because NAA is only locally systemic and high amounts of water slow drying rates for increased absorption. The optimum conditions for maximum absorption are at or near 21°C–24°C (70°F–75°F) and high humidity. Absorption is less on foliage injured by insects, diseases, or frost, and at temperatures below 16°C (60°F). The addition of a non-ionic type spreader sticker, e.g. Agral 90, will improve absorption of NAA under less than ideal weather conditions.

NAA inhibits fruit abscission but the fruit continues to mature at an accelerated rate. The higher the concentration used and the greater the number of applications, the greater the ripening effect. One application of single strength (10 ppm) has little effect on direct ripening. However, it is recommended that apples, particularly McIntosh, not be stored long term (late opening CA or long-term cold) if they have been treated with NAA. Market apples from trees treated a second time with NAA immediately.

Recommendations for Use of ReTain

ReTain is a plant growth regulator that acts as a stop-drop (Honeycrisp, McIntosh, Red Delicious, Northern Spy) and serves as a harvest management material by inhibiting the production of ethylene in maturing apples. Applying this material 4 weeks before the anticipated harvest date has shown it to be an effective pre-harvest drop control agent for apples. ReTain may also delay maturity of apples on the tree, allowing a longer harvest window for a particular variety. Although the ripening process in ReTain-treated fruit is temporarily delayed, treatment with ReTain may result in an increase in soluble solids, colour, fruit size, fruit firmness and a reduction in incidence of water core. Pick fruit treated with ReTain at the same internal maturity (based on starch-iodine tests) as untreated fruit. There may be a 7–10 day delay from the beginning of predicted harvest date of untreated fruit for that year to the beginning of the harvest of ReTain-treated fruit.

Recommended use 4–5 weeks before anticipated harvest

Use one, 333 gram pouch (50 grams a.i.) of ReTain/ 0.40 ha (1 ac.). Use with Sylgard 309 (organosilicone surfactant) at 0.5–1.0 L of Sylgard 309 per 1,000 L of water. The application must be made 4 weeks before anticipated harvest, adjusted for any seasonal differences that have advanced or delayed the "normal" harvest date for that year. If this date is elusive, it is better to be early (5 weeks) rather than late (3 weeks). Late applications will not perform well because ethylene production within the plant may have already begun and this is difficult to suppress once initiated. To help determine the beginning of the "normal" harvest period, refer to historical trends for harvest dates for each cultivar in your area.

Precautions

When mixing ReTain with the surfactant, keep agitation to a minimum as Sylgard 309 has a tendency to foam. To minimize foaming, add Sylgard 309 last and when the tank is full. Compatibility and performance data for ReTain with antifoam products are not available. Surfactants other than Sylgard 309 are presently not registered with ReTain for use in Canada. If the rate of ReTain is reduced, maintain the Sylgard rate at a 0.05% – 0.1% v/v ratio.

Discard any unused spray material at the end of each day. Do not use excessively dilute rates or allow runoff as this may reduce efficacy and wastes product. Do not tank-mix with other products except Dipel or Foray. Combination effects and potential interactions between ReTain and NAA (napthaleneacetic acid) or Ethephon products have not been thoroughly evaluated. Use of these products on ReTain-treated blocks may negate or reduce the benefits of ReTain.

Do not overhead irrigate for 8 hr after applying. Do not apply to the point of runoff, but wet the tree under slow drying conditions. Spray water pH should be between 6 and 8 for best results. Use tree row volume (TRV) reductions cautiously — test on a few rows or small blocks to gain a level of comfort with this technique. For many orchards using size-controlling rootstocks, 1,000 L/water/ha has been shown to be adequate. Adjust water volumes based on tree size and spacing.

For best storage performance of ReTain, segregate treated fruit from untreated fruit to reduce exposure to ethylene.

Additional considerations

Spray only trees that are healthy and not under severe drought, insect, disease or nutritional stress. Royal Gala, Gala, Jonagold and Honeycrisp strains appear to be more responsive to this product in comparison with McIntosh, when using the same treatment parameters. These sensitive cultivar types can be significantly impeded in their maturity and development. As a result, apply treatments to Gala strain, Golden Delicious types and Honeycrisp with caution.

For multiple pick cultivars such as Royal Gala, time application 4 weeks from the 2nd harvest pick date for best results.

The harvest window for treated cultivars (including Gala) is shorter but delayed, resulting in fewer pickings. This can result in increased harvest efficiency.

8. Berry Crops

Berry Crop Nutrition

Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries are developing. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Providing an optimum environment for strawberry root growth is an important step in obtaining a profitable, perennial planting.

Careful and detailed planning is important prior to planting.

pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH, however some micronutrients become less available as pH increases. This may be a problem when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil Acidity and Liming* on page 26.

Fertilizer for New Plantings (the planting year)

Phosphorus (P)

Use soil test results to determine the best rate of phosphorus to apply. Table 8–1, *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, shows soil test values and fertilizer requirements for new strawberry plantings. In the absence of a soil test, select a medium rate from Table 8–1.

Work phosphorus into the soil before planting. Soils differ in the amount of phosphorus available to plants. Generally, fields that have been cultivated for a length of time require less phosphorus than recently developed fields.

Starter Solutions: If the transplanter allows, you could use a starter solution at planting. This helps the plant establish, particularly if the soil is cold, because phosphorus availability is significantly reduced when soil temperatures are low. Use a starter solution high in phosphorus such as 10-52-10, 6-24-6, or 10-24-0. Follow the manufacturer's suggested rate of application.

Potassium (K)

Use soil test results to determine the best rate of potassium to apply. In the absence of a soil test, select a medium rate from Table 8–1.

Incorporate potassium into soil before planting. Side dressing of potassium is not generally recommended.

Nitrogen (N)

Nitrogen can be applied with the P and K, or as a side dressing 2–3 wks after planting. Apply 50 kg of N/ha. See Table 3–8, *Fertilizer Materials — Primary Nutrients*, on page 32 for nitrogen content of fertilizers.

Apply an additional 25–35 kg N/ha in mid-Aug. to further invigorate plants as they initiate fruit buds for the following year's crop. Use whatever form of nitrogen is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. Urea forms of nitrogen may volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of the urea will prevent this problem.

TABLE 8–1. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries

Phosphorus				Potassium		
		Phosphate required kg P_2O_5/ha				Potash required kg K_2O/ha
Soil Test (ppm P)	Rating	New Plantings	Established Plantings	Soil Test (ppm K)	Rating	
0–3	LOW	140	100	0–15	LOW	130
4–5		130	90	16–30		120
6–7		120	80	31–45		110
8–9		110	70	46–60		100
10–12		100	70	61–80		90
13–15		90	60	81–100		80
16–20	MEDIUM	70	50	101–120	MEDIUM	70
21–25		60	40	121–150		60
26–30		50	30	151–180		40
31–40		40	20			
Above 40	HIGH	0	0	Above 180	HIGH	0

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease. Adjust nitrogen rates proportionately if manure has been applied. See Table 3–5, *Average Amounts of Available Nutrients for Different Types of Manure,* on page 29 to determine the adjustments required if manure has been used.

Fertilizer for Established Plantings

Nitrogen (N)

Do not apply nitrogen in the spring, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigour resulting in softer fruit and dense foliage canopies. This increases the potential for botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by a day or two.

Some growers with coarse-textured soils have reported benefits from applying low rates of nitrogen (10–20 kg N/ha) in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

The best time to apply nitrogen in established fields is at renovation. After mowing the foliage, apply 50 kg N/ha using whatever form of nitrogen is economical. (Table 8–2, *Recommended Nitrogen (N) Rates for Strawberries,* on page 98.) Brush pelleted forms such as ammonium nitrate off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. Urea forms of nitrogen can volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporation of the urea will prevent this problem.

An additional 25–35 kg N/ha is recommended in mid-Aug. to assist the plant in forming next year's fruit buds. It is important that soils are well irrigated after renovation, throughout the summer and early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

Phosphorus (P)

If a need for phosphorus is determined by a soil test, apply phosphorus at renovation with the nitrogen and potassium. Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils. In the absence of a soil test or leaf analysis, select and apply a medium rate of phosphorus from Table 8–1.

Potassium (K)

Apply potassium, as determined by a soil test, at renovation with the nitrogen and phosphorus. Application at this timing allows incorporation. Use soil testing and/or leaf analysis to determine what rate to apply. With no soil test or leaf analysis, select and apply, at

One Year Before Planting Strawberries and Raspberries

Adjust soil pH and organic matter at least 1 yr. before planting. Plant a weed-smothering cover crop and incorporate it back into the soil to build up organic matter. Liberally apply well-composted manure (45 tonnes of cattle manure/ha) and incorporate into the soil the year before planting. For information on manure or other sources of organic matter, consult *Managing Soil Organic Matter* on page 28.

Test the field soil for phosphorus, potassium, magnesium and pH. Information on soil testing and a list of soil testing laboratories that have been accredited by OMAFRA can be found in *Benefits of the OMAFRA-accredited Soil Testing Program* on page 23 and Appendix B, *Tissue Testing and Accredited Soil Testing Laboratories in Ontario*, on page 284.

TABLE 8–2. Recommended Nitrogen (N) Rates for Strawberries

	Before planting or 2–3 wks after planting	Renovation (after harvest)	Mid-Aug.
Planting years	50 kg N/ha		25–30 kg N/ha
Established plantings		50 kg N/ha	25–30 kg N/ha

renovation, a medium rate of potassium from Table 8–1. Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

Leaf Analysis for Strawberries

Leaf analysis can be used to assess the nutrient status of strawberry plants and to more accurately determine fertilizer requirements. Take leaf samples by July 1 for fruiting or Aug. 20 for non-fruiting plantings. Collect at least 50 fully expanded, recently matured leaves, with petioles removed. Sample different varieties and plantings separately. See Table 8–3, *Optimum Nutrient Level Range of Strawberry Leaves*, for interpretation of leaf analysis values. For more information refer to OMAFRA Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

Raspberries

Raspberries have a fine, fibrous root system. They prefer a deep, well-drained soil. Raspberry soils should also have good water retaining ability and a high organic matter content, approximately 3%. For more information on organic matter, consult *Managing Soil Organic Matter* on page 28.

TABLE 8–3. Optimum Nutrient Level Range of Strawberry Leaves*

Nutrient	Optimum Range
Nitrogen (N)	2.0%–3.0%
Phosphorus (P)	0.20%–0.50%
Potassium (K)	1.5%–2.5%
Calcium (Ca)	0.5%–1.5%
Magnesium (Mg)	0.25%–0.50%
Manganese (Mn)	20–200 ppm
Iron (Fe)	25–200 ppm
Zinc (Zn)	15–100 ppm
Boron (B)	20–60 ppm

* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before Aug. 20 in non-fruiting fields.

pH Requirements

Raspberries grow best at a soil pH of 5.5–6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil Acidity and Liming* on page 26. Micronutrients may become limiting when soil pH is above 7.0.

Fertilizer for Raspberries

Nitrogen (N)

Recommended nitrogen rates are noted in Table 8–4, *Recommended Nitrogen Rates for Raspberries*, on page 99. Avoid applying excessive nitrogen. It can reduce the number of berries per cane and lead to lower yields. Sources of nitrogen, nitrogen equivalents, are noted in Table 3–8 on page 32.

For summer and fall-bearing raspberries, nitrogen should be applied in early spring (late March-early April). Late applications may lead to winter injury. For fall bearing raspberries, winter injury is not a concern since canes are removed each spring. However, delayed

TABLE 8–4. Recommended Nitrogen Rates for Raspberries

	kg N/ha/season[1]
planting year	30–40
2nd year	40–60
3rd and following years	45–75

[1] Use the lower rates on non-irrigated crops and heavier soils. Apply higher rates to irrigated crops and sandier soils.

ripening before the 1st frost can be a potential problem where nitrogen is applied in excess.

Phosphorus (P) and Potassium (K)

Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test. In the absence of a soil test, assume a phosphorus and potassium level in the medium range. (See Table 8–1) Apply rates accordingly. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc. Phosphorus must be incorporated prior to planting to correct phosphorus deficiencies. Phosphorus does not move readily through the soil from the surface application.

If the soil test recommends high rates of potash, use sulphate of potash (0-0-50) or sulphate of potash magnesia (0-0-22). Raspberries are sensitive to high chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0-0-60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 3–8 on page 32.

Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Complete soil sampling every 2–3 yr.

Leaf Analysis

Collect fully-expanded mature raspberry leaves taken from fruiting canes in late July. Refer to Table 8–5, *Ranges for Nutrient Levels in Raspberry Leaves.* These ranges provide a guide for interpreting results. Variation can occur because of cultivars, soil type and cultural practices.

TABLE 8–5. Ranges for Nutrient Levels in Raspberry Leaves

Element	Range
nitrogen (N)	2.0–3.5%
phosphorus (P)	0.2–0.5%
potassium (K)	1.0–2.0%
calcium (Ca)	0.8–2.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
copper (Cu)	5–20 ppm
boron (B)	20–60 ppm

Currants and Gooseberries

It is essential to adequately prepare soil before planting currants and gooseberries. Prepare the soil at least a year before planting so the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil should have a rich supply of organic matter, at least 2%–3%, to promote good drainage, aeration and moisture retention. Apply 45 t/ha or $20L/m^2$ of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used, but these materials should be well decomposed by planting time. For more information on organic matter consult *Managing Soil Organic Matter* on page 28.

pH Requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil Acidity and Liming* on page 26. Micronutrients may become limiting when soil pH is above 7.0.

Fertilizer Before Planting

Work phosphorus and potassium fertilizer into the soil in early spring a few days before planting. Nitrogen can be incorporated before planting or banded around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen. If planting takes place in the fall, incorporate required phosphorus before planting, but delay application of nitrogen and potassium until the following spring.

Nitrogen (N)

Incorporate or band 5 g of actual nitrogen/bush in the planting year.

Phosphorus (P)

Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. Phosphorus must be incorporated prior to planting to correct phosphorus deficiencies. Phosphorus is not easily leached from the soil. This makes it difficult to correct a problem after the crop is planted. In the absence of a soil test assume a phosphorus level in the medium range and use the rate shown in Table 8–1. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

Potassium (K)

Test the soil before planting and apply the required amount of potassium according to the soil test results. In the absence of a soil test assume a potassium level in the medium range and use the rate shown in Table 8–1. Currants and gooseberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60). Use sulphate of potash or sulphate of potash magnesia.

Fertilizer in Established Plantings

Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, rates should be reduced to the percentage of area receiving the fertilizer. If the fertilizer is banded, band it 30 cm from the base of the plant.

Nitrogen (N)

Apply 10 g nitrogen/bush in the year after planting. In subsequent years, apply 20 g/bush.

Potassium (K)

Apply as according to soil test, or assume a moderate level and apply as indicated in Table 8-1.

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Highbush Blueberries

Blueberries perform best on acidic, well-drained soils with a high organic matter content. Before planting blueberries, test the soil to determine the soil pH and fertilizer requirements. Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will wick soil moisture away from plant roots, so be sure it is thoroughly moistened before planting. For more information see *Managing Soil Organic Matter* on page 28.

pH Requirements

Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically using sulphur or peat moss. For this reason, choose your site for blueberry production carefully.

If the soil pH is too high but less than 6.5, acidify the soil by incorporating elemental sulphur and/or acidic peat moss prior to planting. Refer to Table 8–6, *Amount of Sulphur Required to Lower Soil pH*. Incorporating acidic peat moss with the soil in the planting hole will also provide essential organic matter. Incorporate sulphur 1 yr. prior to planting to allow sufficient time for the sulphur to acidify the soil. Check the soil pH annually in the plant row and add sulphur when necessary.

TABLE 8–6. Amount of Sulphur Required to Lower Soil pH (kg/ha)

Soil Type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1100	110

Example: the initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8.
The soil pH must be lowered by 6.2–4.8 = 1.4 units. Therefore, 1.4 × 750 = 1050 kg/ha of sulphur is required.

Fertilizer for Blueberries

Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N) if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid using the nitrate form of nitrogen on highbush blueberries.

In the spring after planting, apply a total of 12 g of actual nitrogen/bush in a split application. Increase the rate of nitrogen each year until a total of 36–48 g/bush is applied. Apply the nitrogen just prior to bud break, petal fall and early July. Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. On older bushes, apply most of the fertilizer under the outer spread of the branches. See Table 8–7, *Nitrogen Requirements for Highbush Blueberries,* on page 101.

TABLE 8–7. Nitrogen Requirements for Highbush Blueberries

Plant Age	April 1–15	May 15	July 1
	(grams N/plant)		
Newly set	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 8–1 for soil test interpretation. A single application of phosphorus at soil preparation time is usually all that is required. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in spring under the outer branches of the bushes as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (22% potash, 11% magnesium) or potassium sulphate (50% potash). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60).

Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg/ha is required where a confirmed deficiency exists. Magnesium sulphate (Epsom salts, 9.5% Mg) or sulphate of potash magnesia (21% potash, 11% Mg) can be used for soil application. Since sulphate of potash magnesia contains potash, adjust the rate of application to coincide with potash requirements. For foliar sprays, 1.9 kg Mg/1,000 L of water (20 kg magnesium sulphate, Epsom salts) with at least 2,000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

Leaf Analysis

Leaf tissue analysis can be used to assess the nutrient status of the plants and to more accurately determine fertilizer requirements. Take leaf samples in late July from halfway down the new shoot growth of the current season. Collect at least 100 leaves from throughout the area being sampled to adequately represent the area. Sample areas with different soil, plant vigour, fertility programs, etc., separately. See Table 8–8, *Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves.*

TABLE 8–8. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves

Element ( )	Acceptable Range
Nitrogen (N)	1.7–2.3%
Phosphorus (P)	0.15–0.40%
Potassium (K)	0.36–0.7%
Calcium (Ca)	0.3–0.8%
Magnesium (Mg)	0.12–0.3%
Manganese (Mn)	150–500 ppm
Iron (Fe)	30–100 ppm
Zinc (Zn)	10–100 ppm
Boron (b)	15–50 ppm

See Appendix B for a list of accredited labs.

Micronutrients for Berry Crops

Deficiencies of micronutrients or trace elements are not wide-spread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency can have an effect on growth and fruiting.

There is currently no accredited soil test for boron in Ontario. Use a foliar analysis to check for boron deficiencies. Where a boron deficiency has been confirmed, use soil or foliar applications of boron to improve boron in plant tissues. There are several sources of boron, check the manufacturer's recommended rates and timing of applications.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, you can use soil tests to determine the status of manganese in the soil. An OMAFRA soil manganese index value greater than 8 provides adequate manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate. Use a spreader sticker with manganese sulphate. Soil applications of manganese are not effective. Consult manufacturer's label for complete information on rates and timing.

Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only 1 side or 1 branch of the plant is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a foliar analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates[1] have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for rates and timing information.

Blueberries: Iron (Fe) deficiency is common on blueberries if the soil pH is too high. Lowering the soil pH corrects this problem in most cases, and is the preferred method of control. Foliar applications of iron chelates temporarily correct the deficiency, but annual sprays may be necessary. Consult the manufacturer's labels for details on rates and timing.

Zinc (Zn)

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to leaf analysis, you can use soil tests to determine the status of zinc in the soil. An OMAFRA soil zinc index value greater than 8 provides adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

Warning: Do Not Concentrate Nutrient Sprays

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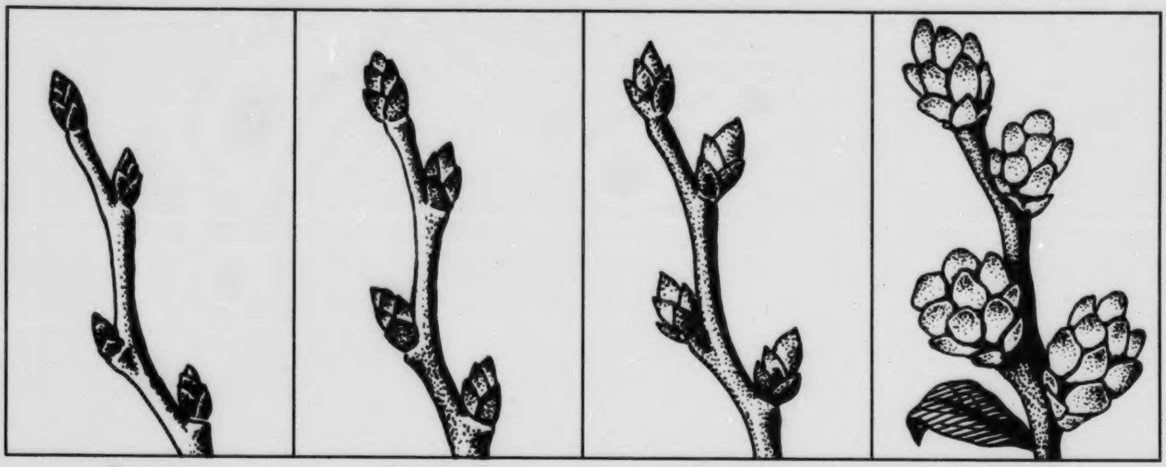
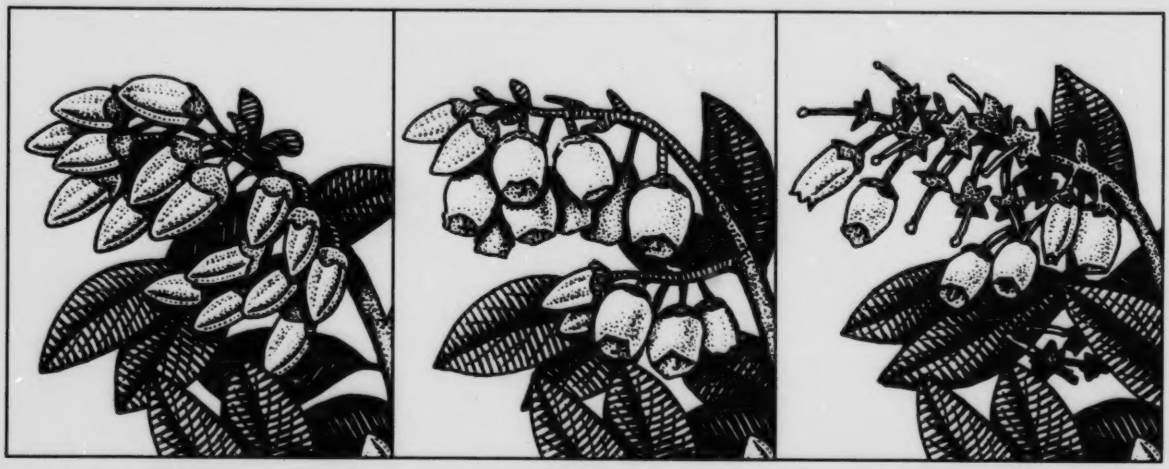
[1] Use chelates recommended for foliar sprays.

Visit the berry page on the OMAFRA Web site at www.gov.on.ca/OMAFRA/english/crops/hort/berry.html

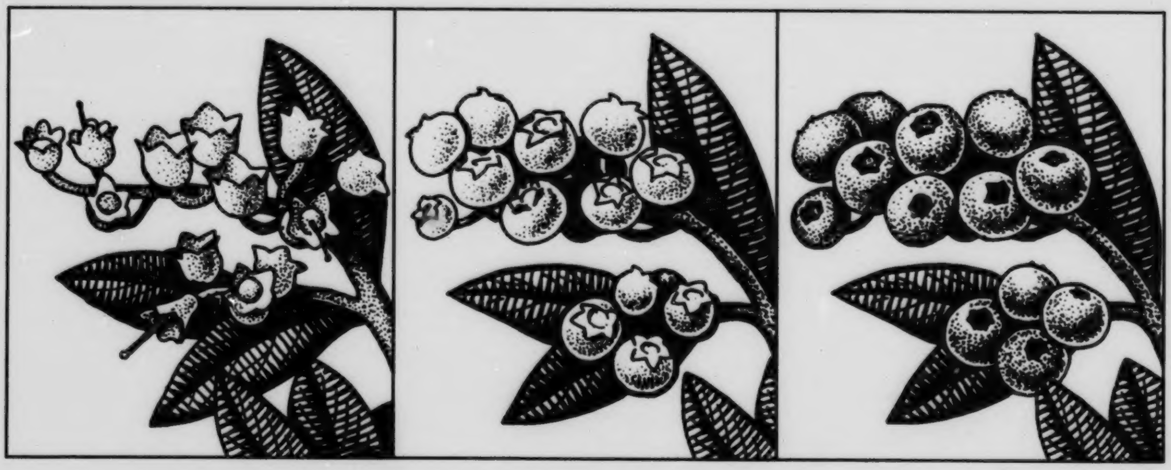
FIGURE 8–1. Blueberry Growth Stages



Dormant Bud Swell Green Tip Bud Cluster



Pink Bud Bloom Petal Fall



Calyx Green Fruit Fruit Ripening

Blueberry Calendar

Read the label and follow all safety precautions.
Always consult the product label for suggested water volumes.
A spray volume of 700–1,000 L of water per hectare is suggested for mature highbush blueberries unless otherwise noted.
Check preharvest intervals on page 105.

Diseases and Insects	Materials	Amount/ha	Comments
Bud Break & Repeat 10–14 Days Later			
Monilinia Mummy berry	• Funginex 190EC • [5]Topas 250E	1.70 L 500 mL	Apply if mummy berry has been a problem.
Bud Swell			
Leaf tiers	• Decis 5 EC	150 mL	Leaf tier larvae cause damage very early in the season. Apply if leaf tier was a problem in the past, at the bud cluster stage as flower buds begin to swell and pink tissue becomes visible.
Green Tip			
Phomopsis stem canker Alternaria Anthracnose fruit rot	• [4]Bravo 500	7.20 L	
Pink Bud			
Phomopsis stem canker Alternaria Anthracnose fruit rot	• [4]Bravo 500	7.20 L	
First Bloom			
Do not apply insecticides while blueberries are in bloom. See *Bee Poisoning* on page 58.			
Botrytis twig and blossom blight Fruit rot	• Captan 80 WDG or [5]Maestro 80 DF • Ferbam 76 WDG	2.00 kg 2.25 kg 3.75 kg	Fungicide sprays for botrytis are more important when wet weather occurs. Repeat at 7–10 day intervals through bloom if weather is wet. Ferbam helps control mummy berry. Do not use Ferbam later than mid-bloom.
Petal Fall			
Cherry fruitworm Cranberry fruitworm	• [4]Guthion Solupak or [4]APM 50W or [4]Sniper 50W • Malathion 25 W • Sevin XLR PLUS	1.12 kg 1.10 kg 1.10 kg 2.25 kg 4.00 L	Repeat 10–14 days later. Guthion or APM also control plum curculio. Malathion also control aphids. Do not use Guthion or APM or Sniper in backpack or home garden-type sprayers.
Phomopsis stem canker Alternaria Anthracnose fruit rot	• [4]Bravo 500	7.20 L	Bravo may cause fruit injury if applied to green fruit.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs. [4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Fruit Ripening			
Fruit rot (*Botrytis*)	• Captan 80 WDG or [5]Maestro 80 DF	2.00 kg 2.25 kg	Applications at 7–10 day intervals may be required if blossom blight phase of botrytis was not controlled.
Blueberry maggot	• Cygon 480AG (highbush) (lowbush) • [4]APM 50W or [4]Sniper or [4]Guthion Solupak • Imidan 50WP • Sevin XLR PLUS • Malathion 25 W	830 mL 580 mL 1.10 kg 2.25 kg 2.25 kg 2.25 kg 4.00 L 2.25 kg	Ontario is considered free from blueberry maggot. Most plantings will not require sprays, however monitor for presence of this pest. Apply the 1st spray when 1st blueberry maggot are trapped or when berries begin to turn blue. This would be about July 5–15, depending on the area and season. Apply a 2nd spray about 5–12 days later, depending on the product. Protection is needed as long as adults are active. APM, Sniper, Imidan and Cygon provide 10–12 days protection under normal conditions. Residual activity of Sevin and Malathion is much shorter. **Cygon**: maximum 2 applications/season. **Imidan**: maximum 2 applications/season. Do not use APM, Guthion or Sniper in backpack or home garden-type sprayers.

Use this table as a guide, but refer to product label for specific information.

TABLE 8–9. Days to Harvest Intervals for Products Used on Blueberries

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
APM 50 W	14	DECIS 5 EC	14	MAESTRO 80 DF	2
BRAVO 500	54	FERBAM 76 WDG	40	MALATHION 25W	1
CAPTAN 80 WDG	2	FUNGINEX 190 EC	60	SEVIN XLR PLUS	2
CYGON 480 AG	15	GUTHION SOLUPAK	14	SNIPER 50 W	14
		IMIDAN 50WP	15	TOPAS 250E	60

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Blueberry Disease Control

Stem Cankers

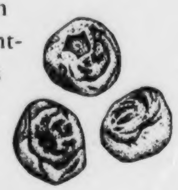
There are several stem cankers and diseases that affect highbush blueberries. Fusicoccum forms distinct elliptical cankers on the lower half of the stem. Phomopsis cankers are less defined than fusicoccum, and appear as flattened and elongated areas on the stem. Both cankers can result in rapid wilting and dying of the blueberry canes.

Symptoms are most obvious in mid-summer when bushes are stressed by cropping or drought. Blueberry plants which are:

- over-fertilized with nitrogen
- growing in poorly drained soils, or
- suffering winter injury

are more susceptible to phomopsis. Prune out and burn diseased canes as soon as they appear.

Anthracnose Fruit Rot

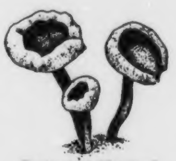


Anthracnose fruit rot is a common fruit rot in Ontario blueberry plantings. This disease is also known as ripe rot because it appears during or after harvest. Anthracnose causes the blossom end of ripe fruit to soften. Frequently, orange spore masses seep out of the infected area.

The disease overwinters in infected twigs. Spores spread by rain splash to bloom and green fruit. Infected green fruit do not show symptoms until they ripen. The disease is favoured by prolonged periods of warm wet weather during bloom and just before harvest. Overhead irrigation can make it worse.

Bravo applied prebloom and petal fall reduces overwintering inoculum and twig blights. After petal fall, fungicides for fruit rot suppress, but do not control, this disease. Manage the disease by pruning to encourage air movement within the bush, and to reduce overwintering inoculum.

Mummy Berry



Trumpet-Shaped Spore Structures

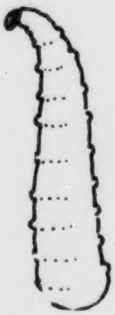
Mummy berry causes 2 types of symptoms on blueberries. The disease overwinters on the ground in fungal structures, or mummies, which are hard, dark pumpkin-shaped structures about the size of a blueberry. In spring the mummies develop trumpet-shaped cups that produce the spores. The spores are released into the air around bud break on blueberries. Primary infection occurs when new shoots and leaves are infected by these spores and suddenly develop a blighted appearance.

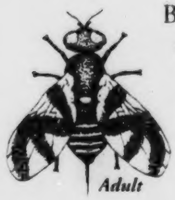
These infected tissues produce a 2nd type of spore, which is spread to healthy flowers. A secondary infection forms at the base of the flower where the berry will develop. Infected berries develop normally at first, but begin to turn pinkish or whitish-grey, harden, and fall to the ground at harvest time.

Certain varieties (i.e. Blueray) seem more susceptible to mummy berry than other varieties. The disease is usually worse in low-lying areas or beside windbreaks where there is little air movement. Control is achieved by destroying or burying the mummies in the ground before they produce the trumpet-shaped fruiting structures. Fungicides are used to protect buds from primary infection.

Blueberry Insect Control

Blueberry Maggot





Blueberry maggot is a white larvae that infests blueberry fruit. It is one of the few larvae found inside mature fruit. Blueberry maggot larvae can be easily distinguished from plum curculio which have a brown head capsule, and cranberry fruitworm larvae, which have legs and a head capsule. Blueberry maggot larvae are white, legless, with no head capsule.

The federal *Plant Protection Act* and *Regulations* place movement restrictions on blueberry fruit, plants, soil and containers from areas known to be infested with blueberry maggot. These laws are in place to prevent the spread of this pest from infested areas — Nova Scotia, New Brunswick, Prince Edward Island, Maine, New York, Michigan — to non–infested areas, such as Ontario, Quebec, B.C. (For more information see *Blueberry Maggot in Ontario*, www.gov.on.ca/ OMAFRA/english/crops/facts/ info_bluemag.htm.)

Ontario is essentially free from blueberry maggot. It was detected on a few farms in 1993-1997 in Norfolk, Niagara and Elgin. Quarantine actions were taken immediately to eradicate blueberry maggot from this area and to prevent its spread. Blueberry growers in areas where blueberry maggot has been detected have a greater risk of infestation in their plantings.

All growers need to monitor for blueberry maggot adult flies. Use sticky yellow traps, baited with ammonium acetate. These traps, also used for apple maggot, are available from many suppliers. Place traps by mid-June on the perimeter of commercial fields. If abandoned or wild blueberries are nearby, place traps just outside of commercial fields. See Appendix F, *List of Monitoring Equipment and Biological Agent Suppliers*, on page 290 for a list of trap suppliers.

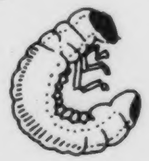
Not all blueberry plantings require insecticides to control this pest. However be aware of the potential for blueberry maggot infestation on your farm. It is not known when or how blueberry maggot arrived in Ontario. It can spread to non-infested areas in infested fruit, picking containers or planting stock. Monitor for blueberry maggot carefully in areas recently planted using planting stock from an infested area.

If you buy blueberries for re-sale on your farm, do not throw away the culls and unmarketable berries. Deep burial, below the plough layer, is the best way to dispose of this material.

You must consider the cost of insecticide application and the potential for loss should maggot be discovered on your farm. In non-infested areas, spraying the border of the planting (outer 6–8 rows of blueberries) and other high-risk areas with a suitable insecticide may greatly reduce the risk of infestation.

Insecticides and timings for blueberry maggot control are listed on page 105. Do not use Cygon on blueberries destined for U.S. markets because there is a zero tolerance for the active ingredient dimethoate on blueberry fruit in the United States. Insecticides are very toxic to bees. Minimize bee exposure by applying insecticides early in the morning or later in the evening when bees are not working. Do not spray blueberry plants in bloom.

White Grubs



White grubs are the larval stage of beetles, including June beetle, European chafer, and Japanese beetle. These beetles lay their eggs in grassy places. The eggs hatch into larvae, or white grubs and feed on plant roots. White grubs are C–shaped, with a tan or brown head capsule and 6 prominent spiny legs.

White grubs can be a pest in blueberry plantings especially in light soil types. White grubs feed on plant roots, causing blueberry bushes to be stunted. They are often associated with mealy bugs and ants.

There are no insecticides registered for white grub control on blueberries. Do not establish new plantings for 2 years after sod or pasture crops. Keep grassy weeds away from the bushes to make the habitat less favorable for white grubs. Clean cultivation between rows may reduce the populations over time.

Grass parking lots can serve as a large reservoir for the build-up of grubs. Treat these grass areas like turf or lawns but **do not treat inside the planting.** If 5 grubs/ft^2 are found, treat with insecticide. There are 3 insecticides registered for use on grubs in turf: diazinon, carbaryl and imidacloprid. Applications of diazinon and carbaryl can be made between mid-Aug. to mid-Sept. when eggs hatch and larvae begin to feed. Apply these insecticides to grass or turf outside the planting, according to label directions, when soil is moist and grubs are feeding near the surface. Imidacloprid is registered for use on European chafer and Japanese beetle grubs only. It can only be applied during grub egg laying from June 1st to Aug. 1st to grass or turf outside the planting. Immediately after applying the insecticides, thoroughly water to allow the insecticide to come in contact with grubs in the root zone just below the thatch (or grass mat layer). For more information on white grubs see OMAFRA Factsheet *Grubs in Lawns,* Order No. 97-023.

Pheromone Traps for Monitoring Cranberry Fruitworm

Pheromones can be used to monitor for cranberry fruitworm. Most growers who have used pheromones to determine the timing of cranberry fruitworm sprays have been able to reduce the number of insecticides applied for this pest.

The pheromone for cranberry fruitworm is species- specific and will not attract cherry fruitworm. Cranberry fruitworm is the major pest in most areas. To distinguish between cranberry and cherry fruitworm, examine the injury they cause. Cranberry fruitworm ties several berries together and frass is present in the tunnels and webbing. Cherry fruitworm feeds on single berries, and frass is only present inside the berry. Use pheromone with Pherecon IC traps. Set traps out around mid-bloom. Use 3 traps for 4 ha (10 acres). Hang traps from the outside branches but not above the bush. Check traps twice weekly and record the number of moths trapped on a chart. Insecticides for cranberry fruitworm can be delayed until 5–10 days after peak catch. A 2nd insecticide is required only if trap catches remain high for an extended period of time.

Pheromone for cranberry fruitworm can be purchased from several suppliers, including Great Lakes IPM and Plant Products Co. Ltd. See Appendix F for a list of trap and pheromone suppliers.

Bird Control

Birds are often the biggest pest problems in a blueberry planting. For information on bird control see *Bird Damage and its Prevention in Fruit Crops* on page 48.

Currant & Gooseberry Calendar

Read the label and follow all safety precautions
Check preharvest intervals below.
For dilute spraying, use 2,000 L of water per hectare, unless label states otherwise.

Diseases and Insects	Materials	Amount/ 1,000L	Amount/ha	Comments
Just Before Blossoms Open				
	Do not apply insecticides while currants or gooseberries are in bloom See *Bee Poisoning* on page 58.			
Leaf spot	• Ferbam 76 WDG	3.35 kg	6.75 kg	Use Ferbam on currants only.
Powdery mildew	• Sulphur 92 WP	2.50 kg	5.00 kg	Do not use on "sulphur-shy" American varieties.
Sawfly Blister aphid	• Diazinon 50 W or Diazinon 500 E or DZN 600 EW • Malathion 25 W	1.00 kg 1.00 L 830 mL 2.50 kg	2.00 kg 2.00 L 1.70 L 5.00 kg	Do not apply Diazinon or DZN 600 EW after bloom. Malathion is not registered for sawfly control.
Postbloom: as soon as bloom is complete				
Leaf spot	Same as for leaf spot above.			
Powdery mildew	Same as for mildew above.			Repeat weekly if warm and humid conditions persist.
Currant fruit fly	• Malathion 25 W	2.50 kg	5.00 kg	Where this pest was a problem, apply a 2nd time in 10 days. For best results apply when the temperature is above 20°C.
10 Days after Postbloom Spray				
Leaf spot	Same as for leaf spot above.			
Currant fruit fly	• Malathion 25 W	2.50 kg	5.00 kg	For best results apply when temperature is above 20°C.
Postharvest				
Leaf spot	Same as leaf spot above.			
Aphids, mites and leafhoppers	• Malathion 25 W	2.50 kg	5.00 kg	Spray red and white currants immediately after fruit is picked.

Use this table as a guide, but refer to product label for specific information.

TABLE 8–10. Days to Harvest Intervals for Products Used on Currants and Gooseberries

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
DIAZINON 500 E	Do not use after first bloom	FERBAM 75 WDG	14
DIAZINON 50W	Do not use after first bloom	MALATHION 25W	3
DZN 600 EW	Do not use after first bloom	SULPHUR 92 WP	1

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs. [4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Currants and Gooseberries Disease Control

Powdery Mildew

This disease is common on currants and gooseberries. The fungus causes a powdery-white growth on the surface of the leaves, shoots and fruits. Infected plants are often stunted and defoliated. Powdery mildew is a limiting factor in black currant production where susceptible varieties are grown.

There are few fungicides registered for control of mildew on currants at this time. Choose resistant varieties. (See Table 8–11, *Disease Ratings on Selected Currant and Gooseberry Varieties.*)

White Pine Blister Rust

White pine blister has a complex life cycle. The rust fungus spends part of its life on wild and cultivated species of gooseberry and currant, and part on white pine (5-needled pine).

Symptoms

Symptoms on gooseberry and currant appear as small slightly raised yellow-orange spots, known as uredia, usually arranged in a circle on the underside of infected leaves. The uredia produce masses of yellow-orange spores that can reinfect currant leaves throughout most of the growing season. Later in the season, brownish hair-like structures, known as telia, develop in the uredia lesions. During cool, wet nights, the hair-like telia produce a small spore that travels not much further than a mile and only infects white pine. In the spring, infected white pine stems and branches produce spindle shaped cankers surrounded by a narrow margin of yellow-orange bark. The cankers develop small, dark brown blisters that ooze spores. The cankers expand producing white sack-like blisters called aecia from which the disease gets its name. The blisters eventually rupture and release masses of orange-yellow spores. These spores can travel hundreds of miles and only infect currants and gooseberries.

Control

White pine blister rust is more serious on white pines than it is on currants. Although the rust disease can defoliate currants, it does not appear to significantly affect yield. However, white pine trees can be killed by this disease. Because white pine blister rust has caused severe economic losses in the forestry industry, currant production is restricted in many parts of the USA. In Ontario, there is no legislation regulating currant production, but black currants, even moderately resistant varieties, should not be grown within a mile of white pines. Destroying wild gooseberry and currant plants within a mile radius between cultivated currants or gooseberries and nearby white pines may help reduce the impact of the disease in a particular area.

TABLE 8–11. Disease Ratings on Selected Currant and Gooseberry Varieties*

Type	Variety	Mildew Resistance	Rust Resistance[1]
Black currant	Ben Alder	Resistant	Very susceptible
Black currant	Ben Connan	Resistant	Moderately resistant
Black currant	Ben Sarek	Resistant	Moderately resistant
Black currant	Titania	Resistant	Resistant
Red currant	Red Lake	Susceptible	Moderately resistant
Red currant	Red Start	Susceptible	Moderately resistant
Red currant	Rovada	Resistant	Moderately resistant
Red currant	Jonkheer van Tets	Resistant	Resistant
Gooseberry	Invicta	Resistant	Moderately resistant
Gooseberry	Hinnonmaki Red	Resistant	Moderately resistant

* not all varieties proven acceptable for Ontario conditions

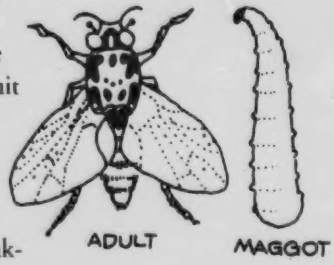
[1] **Resistant**: Does not show symptoms of rust
Moderately resistant: Shows symptoms at low frequency, yield not affected
Susceptible: Noticeable levels of rust infection, not affecting yield
Very susceptible: Severe infection, affecting yield

Source: Adam Dale, University of Guelph, Ontario and Dick McGinnis, McGinnis Berry Crops, B.C., personal communication, 1999

Currant and Gooseberry Insect Control

Currant Fruit Fly

The larva, or maggot, of the currant fruit fly infests currants and gooseberries. The adult fly has a brownish-yellow body, and distinct dark bands on its wings. The adult lays its eggs in young fruit. The larvae feed inside the fruit and infested fruit drops prematurely. The larvae exit the fallen berries, then pupate and overwinter in the soil. Raking up fallen berries will reduce pest pressure. Properly timed insecticide applications will control this pest (page 109).



Imported Currant Worm (Currant Sawfly)

Adults sawflies are active in May and June, laying eggs on the underside of currant leaves. The larva of this pest is a green worm, similar in appearance to a caterpillar, and blends in well with currant foliage. They appear in great numbers and devour foliage before fruit ripens. Bushes can be completely defoliated. Gooseberries are especially susceptible. The larvae pupate in the leaf litter. There are 2 generations each year, although only the first causes significant damage.

Raspberry & Blackberry Calendar

Read the label and follow all safety precautions.
Check preharvest interval on page 114.
For dilute spraying, use approximately 2,000 L water/ha unless otherwise indicated.

Diseases and Insects	Materials	Amount	Comments
Delayed Dormant to Green Tip			
Anthracnose Spur blight Cane blight	• Lime sulphur	Apply 35 L/1,000 L water. Use 1500 L water/ha	**Do not use lime sulphur later than 1/4-inch green.** This is the first step in a good disease control program.
Prebloom (until blossoms open)			
Anthracnose Spur blight	• Ferbam 76 WDG	Apply 2.25 kg/1,000 L water. Use 2,000 L water/ha.	Apply when new canes are 25–30 cm tall and again just before first bloom.
Powdery mildew	• Senator 70WP	Apply 500 g/1,000 L water **or** 1.10 kg/ha	In problem areas, spray when mildew is first observed. Repeat in 7–10 days. To prevent resistance, apply no more than 2 sprays.
Raspberry sawfly	• Diazinon 50 W or DZN 600 EW	Apply 1.0 kg/1,000 L water Apply 830 mL/1,000L water	**Do not apply after 1st bloom.** Diazinon and DZN 600 EW also control aphids and raspberry fruit worm.
Raspberry fruitworm	• Malathion 25 W • Diazinon 50 W or DZN 600 EW	Apply 4.5 kg/1,000 L water Apply 1.0 kg/1,000 L water Apply 830 mL/1,000L water	Repeat in 7–10 days where there is a history of injury. Do not apply Diazinon or DZN 600 EW after 1st bloom.
Spring feeding caterpillars Leafrollers	• [4]Guthion Solupak	Apply 1.75 kg/ha in approx. 1,600 L water/ha	**Guthion and APM:** These products control both spring-feeding caterpillars and leafrollers. Do not use Guthion or APM in knapsack or other home garden-type sprayers.
	or [4]APM 50 W	Apply 1.75 kg/ha in approx. 1,800 L water/ha	**Dipel and Foray:** These are only recommended for the control of leafrollers. Frequent monitoring of leafroller life stages is recommended. Dipel and Foray are most effective on early instars. Two–3 applications may be required to cover the extended emergence of larvae. For best results apply early evening or on cloudy days.
	• Foray 48 BA	Apply 2.8 L/ha in no more than 600 L water /ha	
	or Dipel 2X DF	Apply 550 g/ha	
Clipper weevil	• Malathion 25 W	Apply 4.5 kg in 1,000 L water	Clipped buds and small round holes in petals indicate clipper weevil activity.
Bloom			
Do not apply insecticides while raspberries and blackberries are in bloom. See *Bee Poisoning* on page 58.			
Fruit rots on raspberries	• Rovral 50 WP • Captan 80 WDG or [5]Maestro 80 DF	Apply 2 kg/ha in 1,000 L water/ha Apply 1.2 kg/1,000 L water Apply 2.5 kg/ha	Repeat every 7 days until the end of bloom if wet. Captan or Maestro will provide some control of spur blight. (On blackberry, use Maestro 80 DF at 2.25 kg/ha.)
Green Fruit			
Leafroller	• Foray 48BA	Apply 2.8 L/ha in no more than 600 L water /ha	Chilliwack, Chilcotin, Tulameen and Comox and other varieties from British Columbia are more attractive to leafrollers than other varieties.
	• or Dipel 2X DF	Apply 550 grams/ha	
Leafhoppers	• Malathion 25 W	Apply 4.5 kg/1,000 L water	

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[1]Minimum period for re-entry is 4 hrs. [2]Minimum period for re-entry is 12 hrs. [3]Minimum period for re-entry is 24 hrs.
[4]Minimum period for re-entry is 48 hrs. [5]Minimum period for re-entry is 72 hrs. [6]Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount	Comments
Postharvest			
Leafhoppers	• [4]Guthion Solupak	Apply 1.12 kg/ha in approx. 1,600 L water/ha	Do not use Guthion or Sniper in knapsack or other home garden type sprayers.
	or [4]Sniper 50 W	Apply 1.1 kg/ha in approx. 1,600 L water /ha	
	• Malathion 25 W	Apply 4.5 kg/1,000 L water	
Powdery mildew	• Senator 70 WP	Apply 500 g/1,000 L water **or** 1.10 kg/ha	Repeat every 14 days if disease becomes evident on new growth.
Special Sprays			
Two-spotted spider mite	• Apollo SC	Apply 500 mL/ha Use 500–1,000 L water/ha.	Control weeds and remove fruiting canes immediately after harvest to reduce mite problems. Beneficial mites can be introduced to prevent mite build-up. Alternate miticides from year to year. Thorough spray coverage of leaf undersides is required. Use high water volumes. **Apollo**: Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Apply no more than once/year. **Pyramite**: Do not use Pyramite before harvest. Postharvest application only.
	• [3]Pyramite	Apply 600 g/ha.	
Raspberry crown borer	• Diazinon 500 E	Apply 1 L /1,000 L water. Spray 4,000–5,000 L water/ha.	If more than 5% of the crowns are infested, apply this spray to lower portions of canes and to the crown area. Treat infested plantings at least 2 yr in a row. **Diazinon:** Apply diazinon in 4,000–5,000 L of water/ha. Apply in spring to control young larvae before they tunnel into crowns. Apply when new growth is about 10 cm above ground. Do not apply after bloom. **Guthion:** Apply Guthion in early spring or in mid September to mid October, to control eggs and young larvae. Apply in 1,600 L of water /ha.
	or Diazinon 50 W	Apply 1 kg /1,000 L water. Spray 4,000–5,000 L water/ha.	
	• [4]Guthion Solupak	Apply 2.25 kg/ha in 1600 L water/ha	
Phytophthora root rot	• [2]Ridomil Gold 480EC	Apply 37 mL of Ridomil Gold/100 m of row, to the soil surface in a 1-m band centred over the row. Use at least 2,500 L of water /ha.	**Ridomil**: In new plantings, apply as a post-planting soil drench and again in the fall in mid to late Oct. (no later than Oct. 31). In established plantings, apply Ridomil Gold in the fall only. Do not apply in spring to established plantings. **Aliette**: Aliette WDG is best used as a preventive treatment. Apply no more than 4 applications/yr: 2 in the spring and 2 in the fall. ***Spring application:*** Apply the first spray of Aliette after bud break at 7 cm of new growth and then again 3–4 weeks later. Do not apply within 60 days of harvest. ***Fall application***: Apply when conditions favour disease development (high soil moisture and cool temperatures) and then repeat if necessary 3–4 weeks later. The last fall application should be made at least 30 days before leaf drop. ***Precautions:*** Crop phytotoxicity is possible when Aliette is mixed with copper. Care should be taken if mixing Aliette with nitrogen-based foliar fertilizer. Incompatibility with some suspension concentrate formulations can occur.
	• [2]Aliette WDG	Apply 5.5 kg/ha	

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Use Table 8–12 as a guide, but refer to product label for specific information.

TABLE 8–12. Days to Harvest Intervals for Products Used on Raspberries

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
ALIETTE WDG	60	DIAZINON 50W	PB	MALATHION 25W	1
APM 50W	14	FERBAM 76 WDG	PB	PYRAMITE	PH
APOLLO SC	15	FORAY 48BA	1	RIDOMIL GOLD 480 EC	PH
CAPTAN 80 WDG	2	GUTHION SOLUPAK	14	ROVRAL	1
DIAZINON 500 E	PB	LIME SULPHUR	do not use after 1/4 in. green	SENATOR 70 WP	1
DIPEL 2X DF	1	MAESTRO 80 DF	2	SNIPER	14
DZN 600 EW	PB			VYDATE	PH

PH: Use postharvest only
PB: Do not use after bloom

Raspberry Disease Control

Management Practices to Reduce Diseases on Raspberry

- Plant raspberries on well-drained sites with good air circulation. Plant new raspberries on 25–30 cm (10–12 in.) raised beds to improve drainage and reduce the potential of phytophthora root rot developing. This technique is especially important on sites with clay loams, fluctuating water tables, or where susceptible varieties such as Canby, Taylor, Titan, Lauren and Ruby are being considered.

- Space rows at least 2.5 m apart. Limit width of plants within rows to 30–45 cm. Thin excess canes in the row.

- Immediately after harvest is finished, prune out fruiting canes and weak growth.

- Keep rows free from weeds.

- In spring, prune out and burn canes or portions of canes showing swelling, scars and cracks.

Viruses

Virus diseases, such as raspberry mosaic virus and raspberry leaf curl, are often causes of low yields and poor quality fruit. Aphids are the main vectors that spread these viruses from infected to healthy plantings. Leaves of virus-infected plants may not always show leaf curling and puckering symptoms, or the yellow mottled discoloration known as mosaic. Virus infected plants often produce small crumbly berries and low yields.

Symptoms of virus diseases can be confused with similar symptoms from other causes. For example, herbicide injury, poor crop nutrition, root rots, or drought cause poor vigour and yellowing or curled leaves. Poor pollination, plant bug injury, or a crop nutrition problem also cause crumbly berries.

Some virus diseases can be diagnosed by the Pest Diagnostic Clinic at the University of Guelph (see Appendix E). Diagnosis of virus diseases is difficult, and should be considered only when other potential causes of the problems have been ruled out.

The following steps help minimize the spread of viruses.

- Use virus-tested, disease-free planting stock from an accredited plant propagation program.

- Destroy all nearby wild raspberries and blackberries.
- Set new plantings at least 16 m from older plantings. Do not plant red raspberries close to purple and black raspberries.
- Rogue out and completely destroy all virus-infected plants as soon as symptoms of mosaic or leaf curl appear.

Crown Gall and Cane Gall

Crown gall can be caused by 2 related soil-borne bacteria. It infects raspberry roots, crowns and lower stems of fruiting canes through wounds. The bacteria induce the plant tissue to grow abnormally; resulting in the production of spongy wart-like galls on infected crowns and roots. The galls eventually become hard and woody as they age. Raspberry plants with numerous galls often appear stunted and may become weak. The galls disintegrate over the winter and release the disease-causing bacteria into the soil. New galls often form in the area of the old galls the following spring.

Do not plant canes infected with crown gall. Purchase disease-free plants from an accredited nursery. Do not plant new canes in infested soil. Avoid injury to crown and roots. Maintain good soil fertility.

Verticillium Wilt (bluestem)

Verticillium wilt can be caused by 2 related soil-borne fungi. The fungi infect plants through roots, eventually colonizing and plugging the vascular system. Infected plants may wilt and dry up. Frequently, only canes on one side of infected plant appear wilted. A bluish discoloration on the stem is characteristic of this disease. Black raspberries are much more susceptible than red raspberries to verticillium.

To control verticillium, do not plant raspberries following tomatoes, potatoes, eggplants, or peppers, because these crops are good hosts for the wilt causing pathogens.

- **Red raspberries:** Cut out and destroy infected canes.
- **Black and purple raspberries:** Dig out and destroy infected plants.

See Table 4–5 on page 46 for preplanting soil fumigation treatment.

Orange Rust of Blackberry

This disease only occurs on blackberries, black raspberries and purple raspberries. Infected plants produce weak, spindly shoot growth with yellow misshapen leaves in the spring. Leaves on these shoots develop bright orange pustules on the lower surface. Unlike most fungus diseases, orange rust is systemic in the plant. To prevent the disease from spreading, dig out and destroy infected plants early in the spring before pustules break open.

Fire Blight

Fire blight on raspberry has not been a common problem in Ontario. However, it has caused considerable damage to the variety K81-6 in some infected fields and has also been observed on Boyne. The disease is caused by bacteria, similar, but not identical to the bacteria that cause fire blight on apples and pears.

Primocane tips and laterals of infected raspberry canes appear wilted, black and frequently curve down in the form of a shepherd's-crook. Infected fruit or flower clusters appear water-soaked and eventually turn black. Droplets of white or amber bacterial ooze may be excreted from the lesions of infected tissue. Infected berries become hard, dry and brown, and remain attached to the pedicel.

To avoid fire blight, do not plant susceptible varieties such as Boyne and K81–6. (See Table 8–13, *Relative Resistance of Raspberry Varieties to Cane Infection by Fire Blight,* on page 116.)

Avoid overhead irrigation on susceptible varieties. This practice can cause wounding of tissue, favouring infection, and spreading of the bacteria to healthy plants.

Prune-out infected canes and remove from the planting as soon as observed. Remove infected canes on a dry day to prevent the bacteria from spreading to other canes. Cut the canes out as close to the ground as possible and destroy them. If possible avoid carrying the exposed diseased canes through the field.

Insects with piercing, sucking mouthparts, such as tarnished plant bugs, can spread the fire blight bacteria and encourage infection. Insects that pierce plant tissue, such as earwigs, can also spread the disease. Ants are efficient at spreading the bacteria to healthy blossoms. Monitor for these insects and control them if necessary.

TABLE 8–13. Relative Resistance of Raspberry Varieties to Cane Infection by Fire Blight[1]

Resistant	Partially resistant	Susceptible	Highly susceptible
	Ruby	Kilarney	Carnival
Heritage	Avon	Comox	Boyne
Nova	Polana	Taylor	Reveille
Royalty	K81-6*	Algonquin	Latham
	Caroline	Canby	Encore

[1] based on laboratory tests

* K81-6 is very susceptible to fire bight in the field.

Source: G. Braun, A. Jamieson and P. Hildebrand, Agriculture and AgriFood Canada, Kentville, N.S. 1999

Phytophthora Root Rot

Phytophthora root rot is caused by a soil-borne fungus that is very persistent. The fungus produces spores that swim in water and infect roots and crowns when soil conditions are very wet. The disease frequently appears on plants grown on heavy, compacted or poorly drained soil. Infected plants appear weak with few, wilted primocanes and are frequently found in patches. Confirm diagnosis by digging up plants and scraping away the outer tissue of diseased crowns. Phytophthora infections cause a reddish discoloration just beneath the bark of the infected crown.

Phytophthora root rot can be partially managed by the use of fungicides, but crop management practices are more important than fungicides for preventing and controlling this disease. Select fields with excellent drainage and avoiding low-lying areas. Consider the use of raised beds to keep the water table below the plant roots. Some varieties of raspberries are very susceptible to Phytophthora, while others are fairly resistant. (See Table 8–14, *Field Resistance of Red Raspberry Varieties to Phytophthora Root Rot.*) Avoid growing susceptible varieties, especially in heavier soil types, or on soils prone to flooding.

TABLE 8–14. Field Resistance of Red Raspberry Varieties to Phytophthora Root Rot

Partially Resistant	Susceptible	Very susceptible
Latham	Heritage	Titan
Killarney	Taylor	Canby
Boyne	Newburgh	Ruby
	Royalty	Lauren*

Source: W. Wilcox and M. Pritts, Cornell University, and * field observation

Cane Blight

Cane blight is one of the most serious raspberry cane diseases in Ontario. The pathogen enters primocanes through wounds, and spreads up and down the vascular tissue, causing the cane to become brittle and weak. Diseased canes may die during the winter, or they may leaf out erratically in the spring. Infected canes that appear healthy may collapse or break above the point of injury and infection just as harvest begins. Symptoms of cane blight look similar to those caused by cane and crown borers. Cane blight can be diagnosed by scraping back the bark of infected canes to expose the vascular tissue. The diseased vascular tissue beneath the bark will appear distinctly brown instead of green.

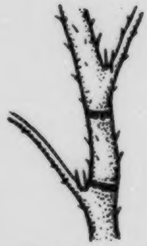
Preventing injury to primocanes prevents cane blight. Canes are wounded by rubbing against trellis wires, by machine harvesters, or by summer pruning. The pathogen frequently enters new primocanes through wounds caused by rubbing against old stubs pruned too high above the ground. Cane blight can be reduced by carefully pruning out old fruiting canes close to ground level after harvest. Avoid pruning or tipping when plants are wet or just before a rain.

Cane blight is one of the most serious raspberry cane diseases in Ontario.

Raspberry Insect Control

Raspberry Cane Borer

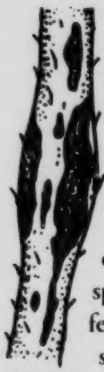
This pest is a long-horned beetle that is active in June and July. It lays eggs in the tips of raspberry primocanes. Canes are girdled with 2 zipper-like rings 15 mm apart. The tip wilts and the larva bores down into the cane where it hibernates. There are no insecticides labelled for control of this pest. Examine canes frequently in June and July for injury. Cut off wilted tips below lower ring as they appear and burn them.



Shoot Tip Damage from Raspberry Cane Borer

Red-Necked Cane Borer

This pest, also known as the rose-stem girdler, is seen occasionally in raspberries in Ontario. It can cause severe damage. The adult beetle is a flat–headed borer that emerges from fruiting canes in late spring or early summer. Eggs are laid on the lower half of the primocanes. Larvae tunnel in a spiral fashion around the cane. The first few spirals under the bark result in a swelling or gall. The larvae continue to tunnel up or down the cane in the pith. Infested canes may wilt or dry up, and often break off at the gall.



Lump or Swelling in Cane from Red-Necked Cane Borer

There are no insecticides registered for control of this pest. Prune out and remove infested canes before spring.

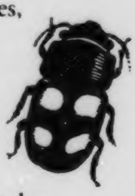
Raspberry Crown Borer

Raspberry crown borers are 2.5 cm, cream coloured larvae with brown heads. They burrow at the base of the cane, in larger roots, and in the crown. Affected canes wither and die, or growth is limited and fruit is small. The adult is a clear-winged moth with a wing-span of 2.5–3.0 cm. The yellow bands across its black abdomen make it resemble a yellow jacket wasp. The adult lays its eggs on plant foliage in summer; larvae travel to the base of the cane to overwinter. They do not tunnel into the cane and crown until the following spring. Larvae spend two years in the crown and root area before they emerge as adults.

To diagnose this pest, you must dig up crowns and look for larvae, sawdust-like frass and tunnelling. Insecticides are targeted at the base of the cane, in fall or early spring, before the larvae tunnel in. Treatment is required for 2 yr to break the cycle of this pest.

Sap Beetles

Sap beetles, also called picnic beetles, are 6 mm long, black with cream markings. They are attracted to ripe fruit, and infest raspberries in the field and after harvest. No chemical sprays give effective control of sap beetles. The pest can be managed by harvesting on a regular basis, and removing damaged and diseased fruit as well as healthy fruit. Bury compost and trash piles or locate them at a different site. Never put boxes of berries on the ground. Remove harvested fruit to a screened building or shelter immediately after picking.



Baits may be used on a small scale to trap beetles. Apple cider vinegar or a mixture of yeast, sugar and water combined with a few drops of liquid detergent will drown the beetles. Commercially prepared bait containing the insecticide carbaryl is available.

Strawberry Calendar

Establishment Year — New Plantings

CULTURAL CONTROL

Use these techniques to suppress pest populations.

Diseases & Insects	Management Practice	Comments
Between plantings		
White grub Wireworm	Crop rotation	Consider cultivated row crops such as snap beans, white beans, cabbage, broccoli, brussels sprouts and cauliflower. Avoid preferred hosts such as corn, grasses, cereal species and potato.
Root lesion nematode White grub Root weevil Wireworms Annual and perennial weeds Two-spotted spider mite	Summer fallowing	Cultivate to 10 cm (4 in.) frequently enough to kill young weeds and discourage weed growth. Avoid this practice on sloping land prone to erosion. Sow oats or spring wheat in September as a cover crop to minimize soil erosion by wind and water. Do not use cereal rye, because this encourages nematodes. For more details on preplant weed control, consult Chapter 12, *Weed Management for Fruit Crops*. Refer to the "Site Preparation" and "Special Methods of Weed Control" sections.
Before planting		
Verticillium Red stele Leather rot Black root rot	Site selection Crop rotation	Select a site with good soil drainage. Avoid heavy, poorly drained soils. Avoid sites with a history of red stele and verticillium. Avoid susceptible crops preceding strawberry such as potato, tomato, peppers, eggplant and alfalfa. Those crops favour build-up of verticillium in the soil.
Botrytis fruit rot Leaf scorch Leaf spot Leaf blight	Site selection	Select a planting site with good air drainage. Expose plants to direct sunlight and plant rows parallel with the direction of the prevailing winds to promote fast drying of foliage and fruit.
Root weevil Cyclamen mite	Isolation	Isolate new plantings from older infested plantings to provide a physical barrier to reduce land migration of these pests.
Red stele Verticillium	Cultivar selection	Choose varieties that have some resistance to the red stele fungus *Phytophthora fragariae* and verticillium. See Table 8–16, *Strawberry Variety Disease Ratings*, on page 126 for more information. Use only plants that have been grown under the guidelines of an accredited plant propagation program.

Establishment Year — New Plantings

CHEMICAL CONTROL

Read the label and follow all safety precautions.
Use enough water when spraying to thoroughly wet plants.

Diseases and Insects	Materials	Amount/ha	Comments
Use only plants grown under the guidelines of an accredited plant propagation program.			
Early June			
Strawberry leafroller	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Malathion 25 W	1. 12 kg 1. 10 kg 1.10 kg 4.25 kg	
One Month After Planting and again ONCE or TWICE at 2 Week Intervals			
Leaf blight Leaf scorch Leaf spot	• Copper 53W • Equal 65WP • Captan 80 WDG or [4]Maestro 80 DF	3.80 kg 1.75 kg 4.2 kg 4.2 kg	Good coverage of lower leaf surface is essential for control of leaf spot. Copper, Captan and Maestro are labelled for leaf spot only. Spray susceptible varieties such as Bounty, Kent, Veestar, Tristar, Micmac and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays see *Use of Copper Products on Fruit Crops* on page 51. Equal may injure plants under cold weather conditions. Alternate between copper and Equal to reduce resistance development.
July to mid Aug.			
Potato leafhopper	• Malathion 25 W	4.25 kg	Check underside of leaves and spray when nymphs are present. Repeated applications may be necessary for leafhopper control.
Fall			
Red stele			To reduce the chance of resistance developing, this application is only necessary where red stele has been observed and confirmed.
	• [2]Ridomil Gold 480 EC	1.0 L	**Ridomil Gold:** Make 1 application in early Sept. and a 2nd treatment in late Oct., but not later than Oct. 31. Apply as a broadcast application in sufficient water (2,500 L/ha) to ensure movement into the root zone.
	• [2]Aliette WDG	5.60 kg	**Aliette:** Make a maximum of 4 applications/season, 2 in the spring and 2 in the fall. Apply as a foliar spray in spring when plants start active growth. Apply at 30–60 day intervals. Make fall applications when soil conditions favour disease development (e.g., high soil moisture and cool temperatures).

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[1] *Minimum period for re-entry is 4 hrs.* [2] *Minimum period for re-entry is 12 hrs.* [3] *Minimum period for re-entry is 24 hrs.*
[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Bearing Years

CULTURAL CONTROL

Use these techniques to suppress pest populations.

Diseases & Insects	Management Practice	Comments
Late April to Early May		
Plant bugs Spittle bug Two-spotted spider mite Botrytis fruit rot Leather rot	Weed control	Broadleaf weeds provide alternate hosts and encourage the build up of plant bug and two-spotted spider mite populations. Grassy fence rows or volunteer grass in the planting provide alternate hosts and build up of spittlebug populations. Weeds keep relative humidity high and prolong leaf wetness, thus encouraging fruit rots.
Mid to Late May		
Leather rot	Straw mulch	Apply straw mulch, thick enough to prevent soil from splashing onto berries, at petal fall and prior to significant berry formation.
Botrytis fruit rot Leather rot Black root rot	Fertilization	Avoid excessive fertilization that can encourage too much foliar growth, creating a dense, humid canopy.
Preharvest to Harvest		
Botrytis fruit rot Leather rot Black root rot Verticillium Red stele	Irrigation scheduling	Irrigate during the day (10:00 am– 3:00 pm). Irrigate for short periods to allow foliage and fruit to dry out before nightfall. Do not apply too much water at one time. Avoid creating puddles.
Renovation (early July)		
Two-spotted spider mite Powdery mildew	Mowing	Mow off strawberry leaves to eliminate the food source for these pests, and reduce the population.
Botrytis fruit rot Leather rot	Narrowing rows	Narrow the width of matted row to 30 cm (12 in.) to decrease plant density and encourage airflow and quick drying of the crop canopy. Incorporate plant crop residues into the soil and rototill to destroy the main source of botrytis. If runnering is too vigorous, narrow the rows again in Oct. using a coulter.
Renovation		
Black root rot	Subsoiling	Subsoiling in late July or Aug. reduces compaction and improves soil drainage.

CHEMICAL CONTROL

Read the label and follow all safety precautions.
Observe preharvest intervals on page 123.
Use enough water when spraying to thoroughly wet the plant.

Diseases and Insects	Materials	Amount/ha	Comments
When New Growth Appears			
Botrytis grey mould	• [4]Bravo 500	3.50 L	Bravo helps control botrytis by reducing disease inoculum and preventing infection of dying leaves. Repeat application in 10 days.
When Flower Buds are Visible in the Crown			
Leaf blight Leaf scorch Leaf spot	• Copper 53 W • Equal 65 WP • Captan 80 WDG or [4]Maestro 80 DF	3.80 kg 1.75 kg 4.20 kg 4.20 kg	Captan, Maestro and Copper are labelled for leaf spot. Good coverage of the lower leaf surface is essential for leaf spot control. Spray susceptible cultivars such as Bounty, Kent, Veestar, Micmac, Tristar and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays, see *Use of Copper Products on Fruit Crops* on page 51. Equal may injure plants under cold weather conditions.
Cyclamen mite	• Thiodan 50WP or Endosulfan 50W or Thiodan 4 EC	4.00 kg 4. 00 kg 5.0 L	Apply one of these chemicals in 5,000–8,000 L of water/ha as a drench over the plant row.
As Flower Buds Extend from Crown			
Strawberry clipper weevil	• [4]Furadan 480F • Cymbush 250EC or Ripcord 400EC • [3]Matador 120EC	1.10 L 280 mL 175 mL 104 mL	Check edges of fields for clipped buds. Apply insecticide when 1st injury is detected. A 2nd application may be required if new injury is detected 7 days after the first spray. Do not use Furadan later than bloom because of its toxicity to pollinating and beneficial insects. Use Furadan only once during the season. Note: Furadan can cause extensive burning of sepals surrounding fruit on certain varieties (e.g. Annapolis, and Cavendish).
First Bloom			
Insecticides are very toxic to bees. Do not spray when bees are working. Spray in the evening. See *Bee Poisoning* on page 58.			
Plant bugs	• Cygon 480 • Cymbush 250EC or Ripcord 400 EC • Decis 5 EC • [3]Matador 120 EC • Thiodan 50WP or Endosulfan 50 W	2.75 L 400 mL 250 mL 200 mL 104 mL 2.00 kg 4.00 kg	Cymbush, Ripcord, Matador or Decis also control clipper weevil. Thiodan, Cymbush, Ripcord, Matador or Decis also control spittlebug.
Botrytis grey mould	• [2]Rovral • Folpan 50 WP • Captan 80 WDG or [4]Maestro 80 DF • [5]Ronilan EG • [1]Elevate 50 WDG	2.00 kg 4.00 kg 4.20 kg 4. 20 kg 2.00 kg 1.70 kg	Keep all flower parts protected with fungicide during bloom for good control of botrytis. Typically 2–3 sprays during bloom will give good control. Shorten intervals to 3–5 days if weather is wet. Use Rovral, Ronilan, or Elevate when disease pressure is high. Since Rovral and Ronilan are in the same chemical family, do not use them in consecutive sprays or more than 2 sprays/season. Alternate with other fungicides. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 41.
7 to 10 Days after First Bloom			
Plant bugs	• Cymbush 250EC or Ripcord 400 EC • Decis 5 EC • [3]Matador 120 EC • Thiodan 50WP or Endosulfan 50W	400 mL 250 mL 200 mL 104 mL 2.00 kg 4.00 kg	

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Botrytis grey mould	• [2]Rovral • Folpan 50 WP • Captan 80 WDG or [4]Maestro 80 DF • [5]Ronilan EG • [1]Elevate 50 WDG	2.00 kg 4.00 kg 4.20 kg 4.20 kg 2.00 kg 1.70 kg	Shorten intervals to 3–5 days if wet weather persists. Use Rovral, Ronilan, or Elevate when disease pressure is high.
Preharvest			
Slugs	• Metaldehyde bait		Most insecticides listed above have some activity on slugs. Distribute bait along edge of rows but not on strawberry plants. Keep children and domestic animals from treated areas. Read label about poisoning. Very poisonous to dogs.
Two-spotted spider mite	• Kelthane 50W • Apollo SC • [3]Pyramite	2.00 kg 500 mL 600 g	Coverage of the underside of leaves is essential for good control. Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Apply no more than once/year. Thorough spray coverage of leaf undersides is required. Use high water volumes. To discourage resistance, alternate products from year to year.
Botrytis grey mould	• [2] Rovral • Folpan 50 WP • Captan 80 WDG or [4]Maestro 80 DF • [5]Ronilan EG • [1]Elevate 50 WDG	2.00 kg 4.00 kg 4.20 kg 4.20 kg 2.00 kg 1.70 kg	If irrigation is necessary, water early in the day to allow plants to dry off before nightfall.
Renovation (After mowing)			
Cyclamen mite	• Thiodan 50WP or Endosulfan 50W or Thiodan 4 EC	4.00 kg 4.00 kg 5.0 L	Apply one of these chemicals in 5,000–8,000 L of water/ha as a drench over the plant row.
Renovation (After mowing, to new growth)			
Two-spotted spider mite	• Kelthane 50W • Apollo SC • [3]Pyramite	2.00 kg 500 mL 600 g	Coverage of the underside of leaves is essential for good control. Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Apply no more than once/year. Thorough spray coverage of leaf undersides is required. Use high water volumes. To discourage resistance, alternate products from year to year.
Fall			
Botrytis grey mould	• [4]Bravo 500	3.50 L	Bravo helps control botrytis by reducing disease inoculum. Apply late Oct.
Leaf blight Leaf scorch Leaf spot	• Copper 53W • Equal 65WP • Captan 80 WDG or [4] Maestro 80 DF	3.80 kg 1.75 kg 4.20 kg 4.20 kg	Copper is only labelled for leaf spot. Spray susceptible varieties such as Bounty, Kent, Veestar, Micmac, Tristar, and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays see *Use of Copper Products on Fruit Crops* on page 51. Equal may injure plants in cold weather. Alternate between copper and Equal to reduce the development of resistance. Good coverage of the lower leaf surface is important for leaf spot control.
Red stele			To reduce the chance of resistance developing, this application is only necessary where red stele has been observed and confirmed. Apply as an overall application in sufficient water (2500 L/ha) to ensure movement into the root zone.
	• [2]Ridomil Gold 480 EC	1.0 L	Do not apply Ridomil Gold later than Oct. 31 or in the spring on established plants.
	• [2]Aliette WDG	5.60 kg	With Aliette, make a maximum of 4 applications per season, 2 in spring and 2 in fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Do not apply within 30 days of harvest, or after 1st bloom. Make postharvest applications when soil conditions favour disease development (e.g., high soil moisture and cool soil temperatures).

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[1]Minimum period for re-entry is 4 hrs. [2]Minimum period for re-entry is 12 hrs. [3]Minimum period for re-entry is 24 hrs. [4]Minimum period for re-entry is 48 hrs. [5]Minimum period for re-entry is 72 hrs. [6]Minimum period for re-entry is 7 days.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Use this table as a guide, but refer to product label for specific information.

TABLE 8–15. Days to harvest intervals for products used on Strawberries

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
ALIETTE WDG	30	DECIS 5 EC	14	MATADOR 120 EC	7
APOLLO SC	15	ELEVATE 50 WDG	1	PYRAMITE	10
BRAVO 500	30	ENDOSOLFAN 50 W	7	RIDOMIL GOLD 480 EC	PH
CAPTAN 80 WDG	2	EQUAL 65 WP	7	RIPCORD 400 EC	7
COPPER 53W	1	FOLPAN 50 WP	1	RONILAN EG	3
CYGON 480	7	FURADAN 480 F	PB	ROVRAL	1
CYMBUSH 250 EC	7	KELTHANE	7	THIODAN 4EC	7
		MAESTRO 80 DF	2	THIODAN 50 WP	7

PB: pre-bloom only
PH: post harvest only

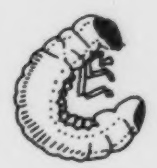
Strawberry Insect Control

Monitoring methods and thresholds have been established for several strawberry pests. See the following OMAFRA factsheets and information sources:

- Order No. 92-108, *Tarnished Plant Bug*
- Order No. 99-031, *Strawberry Clipper Weevil*
- Publication 513, *Growing Strawberries in Ontario*

White Grubs

White grubs are the immature stage of scarab beetles, including June beetle, European chafer, and Japanese beetle. They are C-shaped, with a tan or brown head capsule and 6 prominent spiny legs. These beetles usually lay their eggs in sod, or other grassy places. The eggs hatch into larvae, or white grubs that feed on plant roots.



White grubs feed on strawberry plant roots, causing plants to be stunted. Damage is most common in lighter soil types when strawberries are grown after pasture, sod or, occasionally, a grassy crop.

There are no insecticides registered for white grub control on strawberries. Do not establish new plantings for 2 yr after sod or pasture crops. Keep grassy weeds under control to make the habitat less favourable for white grubs.

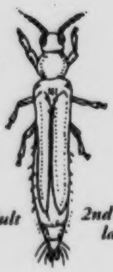
Grass parking lots can serve as a large reservoir for the build-up of grubs. Treat these grass areas like turf or lawns but **do not treat inside the planting**. If 5 grubs per 1/10th of a m^2 (1 ft^2) are found, treat with insecticide. There are 3 insecticides registered for use on grubs in turf: diazinon, carbaryl and imidacloprid. Applications of diazinon and carbaryl can be made between mid-Aug. to mid-Sept. when eggs hatch and larvae begin to feed. Apply these insecticides according to label directions when soil is moist and grubs are feeding near the surface. Imidacloprid is registered for use on European chafer and Japanese beetle grubs only. It can only be applied during grub egg laying from June 1st to Aug. 1st. Immediately after applying insecticides, thoroughly water to allow the insecticide to come in contact with grubs in the root zone just below the thatch (or grass mat layer). For more information on white grubs refer to OMAFRA Factsheet *Grubs in Lawns*, Order No. 97-023.

Fruit Bronzing Caused by Thrips

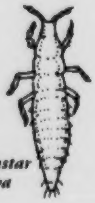
Symptoms of fruit bronzing occur when king berries reach 5–10 mm in diameter. Close inspection of strawberry fruit will reveal a necrotic flecking or bronzing of the seeds and fruits especially beneath the calyx. The entire fruit may become bronzed and cracked.

Most fruit bronzing is caused by flower thrips. Cyclamen mites and two-spotted spider mites can also cause bronzing. Thrips are tiny, yellow insects that begin feeding in the bloom, and, as the berry sizes and seeds separate, they begin feeding on the fruit.

Thrips do not overwinter in Ontario, but migrate each spring on air currents from the south. They are attracted to white flowers, and therefore to strawberry bloom that is open when the thrips arrive. They do not cause problems on strawberries every year.



Adult

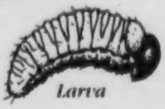


2nd instar larva

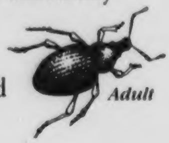
Monitoring techniques and control strategies for thrips have not been worked out in Ontario. There are no registered insecticides for thrips. Insecticides applied for control of strawberry clipper weevil and tarnished plant bug also suppress thrips.

Root Weevils

The black vine weevil, the strawberry root weevil and the rough strawberry root weevil are all strawberry pests. The weevil larvae, or grubs, are about 1 cm in length, with cream-coloured, legless C-shaped bodies with brown heads. They are generally smaller than white grubs. Adults are beetles in the weevil family and can be identified by their characteristic long, probing mouthpart called a snout. The adults are wingless and migrate by crawling across land. They feed at night, chewing C-shaped notches on edges of strawberry leaves. Although there is only one generation a year, populations can build rapidly, within 2 yr of planting.

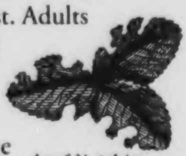


Larva



Adult

Root weevils overwinter as larvae in soil. In late fall and spring, these larvae feed on strawberry roots causing plants to be stunted and die. Adults begin to emerge from the soil during harvest. Adults are in the field throughout July and early Aug., when they feed and lay eggs on strawberry leaves. When the eggs hatch, larvae move into the soil to feed on fine rootlets and overwinter. Root damage is not usually evident until the following spring.



Leaf Notching from Root Weevil Feeding

When insecticides are applied for control of strawberry clipper weevil, they suppress existing root weevil populations by killing early emerging adults and some larvae that may still be feeding. However, this timing is too early to kill the majority of emerging adults and too late to kill most larvae which have already finished feeding on the roots. Peak emergence and egg laying by adults occurs in July after harvest is completed. Till the soil between the strawberry rows at renovation to expose root weevil populations and reduce their numbers. Do not establish new plantings near older, infested plantings.

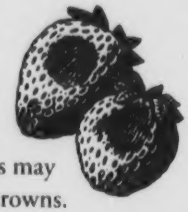
Strawberry Disease Control

Leather Rot

Leather rot can infect strawberry bloom, green fruit or mature fruit. Green fruit become hard and leathery. Ripe fruit develop a purplish colour and a foul odour.

Some fungicides used for botrytis control will reduce the incidence of leather rot, although none are registered for the control of this disease. Rovral, Ronilan and Benlate do not control leather rot. Leather rot is worse under cool, wet, harvest conditions. Infection is more common where insufficient straw is applied. The most effective control for leather rot is a thick layer of straw mulch between the rows to prevent berries from touching the soil and soil from splashing to fruit.

Anthracnose Fruit Rot



Symptoms of this disease include brown or black sunken circular lesions on green or ripe fruit. Salmon coloured spore masses ooze from these lesions in humid conditions. Distinct, dark, sunken lesions may form on petioles and runners, and crowns. These lesions may cause daughter plants to die, outer leaves to die prematurely, or the plant may collapse from crown rot. Certain varieties, i.e. G19 seem to be very susceptible.

Anthracnose is not a common problem in Ontario and its occurrence is very weather dependent. It is favoured by splashing rains, and warm humid weather, especially close to harvest. Day neutral varieties, and plants grown in plasticulture systems are more likely to be exposed to these conditions, and are at higher risk of anthracnose than June-bearing varieties in matted rows.

The disease overwinters on infected plant debris. Spores are spread by rain-splash to bloom and fruit. Spores may also be spread on equipment and workers. Spores may be present on symptomless plants.

There are no registered fungicides for anthracnose control. Purchase plants from an accredited propagator. Remove infected fruit from the field during harvest. Clean up crop debris between crops. Work in infected fields last. Use straw mulch to reduce rain splash. Vigorous plants high in nitrogen seem to be more susceptible to this disease, so avoid over-use of nitrogen.

Angular Leaf Spot

Angular leaf spot causes angular dark green spots on the lower leaf surface. It can also spread to the sepals causing the fruit calyx to turn black, making fruit unmarketable.

Angular leaf spot is a bacterial disease and is not controlled by fungicides. Disease pressure is highest where frost has been frequent during bloom and overhead irrigation has been used to protect against frost. Cool spring conditions with frequent rainy periods are ideal for the development and spread of this disease.

Heavily fertilized and very vigorous plantings are most susceptible, so avoid over-use of N. Certain varieties are more susceptible than others (Table 8–16, *Strawberry Variety Disease Ratings*, on page 126) but if disease pressure is high all varieties can become infected.

Nematodes

Nematodes are microscopic wormlike creatures that live in soil and feed on strawberry roots. They can cause stunting of plant growth, and make plants more susceptible to verticillium infection. Strawberries have a lower threshold than many other fruit crops for root lesion nematodes. Nematodes must be controlled before planting. For more information on nematodes and control, refer to *Nematodes in Berry Crops* on page 45.

TABLE 8–16. Strawberry Variety Disease Ratings

	Leaf Spot	Leaf scorch[6]	Powdery mildew	Botrytis rot	Verticillium	Red Stele[1] Race C-2	Red Stele[1] Race C-3	Red Stele[1] Race C-4	Red Stele[1] Race C-6	Red Stele[1] Race C-7	Bacterial angular leaf spot[4]
Allstar[2]	MR*	S	MR	MR	MR	R	MR	R	S	?	HS
Annapolis	MR	MR	S	S	MR	R	R	R	R	S	HS
Bounty	MR	MR	MR	MR	HS	R	S	S	R	R	S
Cavendish	MR	R	MR	MR	MR	R	R	R	R	S	HS
Chambly	R	MR	R	?	?	MR	S	?	S	?	?
Glooscap	MR	MR	MR	S	S	S	S	S	S	S	S
Gov. Simcoe	MR	MR	HS	MR	MR	S	S	S	S	S	S
Honeoye	MR	MR	MR	MR	HS	S	S	S	S	S	HS
Jewel[3]	HR	MR	HR	MR	S	S	S	S	S	?	HS
Kent	HS	S	MR	S	S	S-MR	S-MR	S	S	S	HS
Micmac	S	HS	MR	S	MR	S-MR	S-MR	S	S	S	S
Mohawk[5]	?	MR	MR	?	?	HR	HR	R	MR	?	?
Redcoat	MR	MR	MR	HS	S	S	S	?	S	S	MR
Scotland	MR	R	MR	MR	MR	?	?	?	?	?	?
Settler	MR	MR	HS	MR	MR	?	?	?	?	?	S
Sparkle	S	MR	MR	MR	S	S	HR	S	HR	HR	?
Startyme	S	S	S	?	?	?	?	?	?	?	?
Tribute	MR	MR	S	MR	R	MR	R	R	MR	?	?
Tristar	MR	MR	S	MR	R	R	R	R	MR	?	?
Vantage	R	R	R	MR	R	R	R	?	R	?	S
Veestar	S	MR	S	MR	MR	S	R	S	R	S	MR

HR Highly Tolerant; **R** Tolerant; **MR** Moderately Tolerant; **S** Susceptible; **HS** Highly Susceptible; **?** Unknown

* Race Dependent

[1] Red stele ratings from Dr.N. Nickerson and Dr. A.Jamieson, Agriculture & Agri-Food Canada, Kentville, Nova Scotia (1998): The following Canadian races equate to American Races C2=A6, C3=A4, C4=A3, C6=A7

[2] Gene Galletta, USDA, Maryland, (1991)

[3] Marvin Pritts, Cornell, N.Y. (1991)

[4] Based on field observation; subjective evaluation

[5] Galletta, Mass, Enns & Draper, 1995

[6] Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996

TABLE 8–17. Effect of Fungicides on Strawberry Diseases*

	Captan and Maestro	Folpan (folpet)	Elevate (fenhexamid)	Rovral (iprodione)	Ronilan (vinclozolin)	Equal (dodine)	Benlate (benomyl)	sulfur	copper	Ridomil (metalaxyl)	Aliette (fosetyl-al)
Anthracnose *(C. acutatum)*	++	++	0	0	0	0	0?	0	+P	0	0
Anthracnose *(C. gloeosporioides)*	++	++	0	0	0	0	+R	0	+P	0	0
Grey mould	++	++	+++	+++R	+++R	0	++R	0	+P	0	0
Powdery mildew	0	0	0	0	0	0	+R	++P	+P	0	0
Common leaf spot	+++	+++	?	++	++ to +++	++ R	++	0	+P	0	0
Leaf scorch			0			++R	++	0	+P	0	0
Phomopsis leaf blight and fruit rot	+ to ++	+ to ++	0	0	?	?	++	0	+P	0	++
Leather rot	+	+	0	0	0	0	0	0	+P	++	++
Angular leaf spot	0	0	0	0	0	0	0	0	+P	0	0
Phytophthora crown rot	0	0	0	0	0	0	0	0	0	++ to +++	++
Red stele root rot	0	0	0	0	0	0	0	0	0	++ to +++	++

* Use fungicides only for control of diseases listed on the product label.

0 = no control, + = poor to fair control, ++ = good control, some limitations, +++ = excellent control, few if any limitations

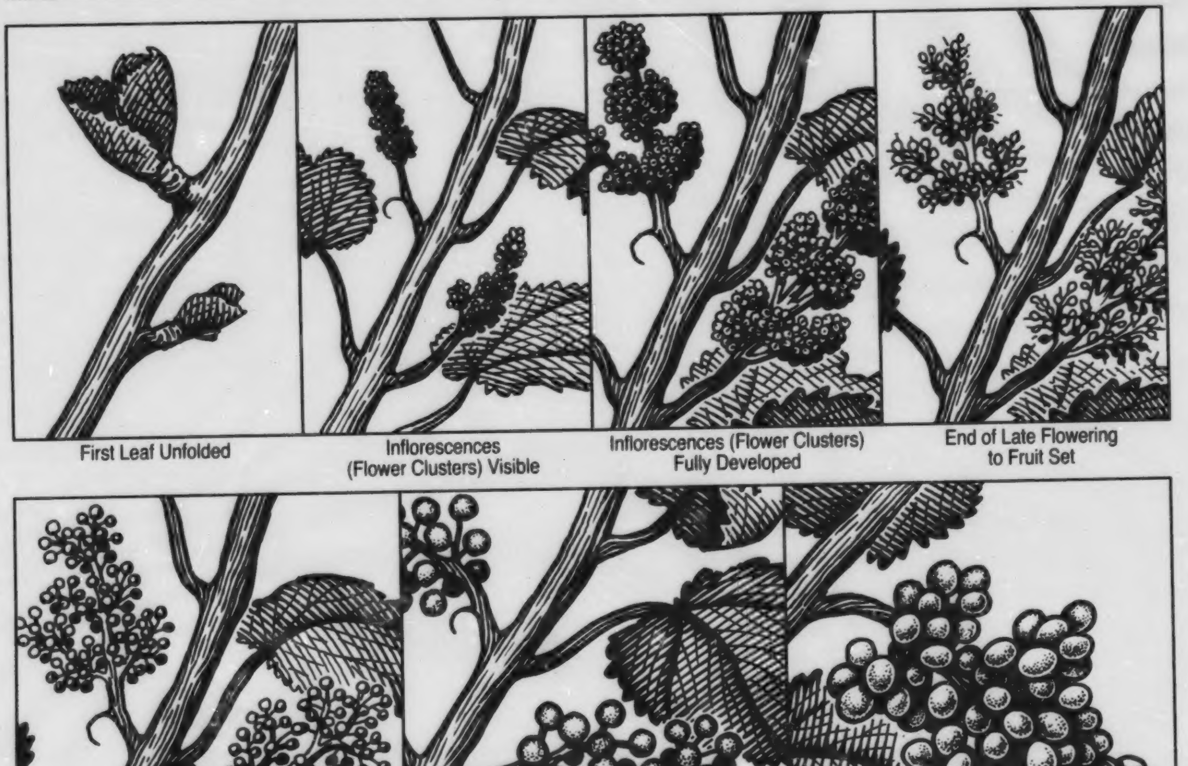
R = pathogen resistance (insensitivity) to the fungicide has occurred in some locations

P = may be phytotoxic, ? = suspected level of control, needs confirmation.

Source: W. McFadden-Smith, University of Guelph, Vineland, based on information developed by the IR4 Project at the annual Small Fruit Workers Meeting, August 1999

9. Grapes

FIGURE 9–1. Grape Growth Stages



First Leaf Unfolded

Inflorescences (Flower Clusters) Visible

Inflorescences (Flower Clusters) Fully Developed

End of Late Flowering to Fruit Set

Berries Lead Shot Size

Berries Pea-sized

Beginning of Berry Touch

Berry Touch

Beginning of Ripening

Late Stage of Ripening

Grape Nutrition

It is important to prepare and test soil before planting vines. Well in advance of planting prepare the soil through tillage and adding organic matter to ensure long-term productivity of these perennial crops. For information on building and maintaining soil organic matter see *Managing Soil Organic Matter* on page 28 and *Manure for Vineyards*, below.

Prior to planting, ensure that nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to *Fertilizer for Grapes* on page 130. Preplant applications of phosphorus, potassium and lime are the most effective.

Manure for Vineyards

A spring application of manure is beneficial in providing nutrients and organic matter to established vineyards. Manure can also be applied in the fall prior to new spring plantings.

Broadcast manure at no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 t/ha of cattle (100 m^3 liquid) or 35 t/ha hog (65 m^3 liquid). Manure is extremely variable in nutrient content and should be analyzed before application. When manure is used, reduce the rate of fertilizer. Table 3–5, *Average Amounts of Available Nutrients for Different Types of Manure*, on page 29 shows the average composition of some manure and the suggested reduction of fertilizer when manure is used.

Nitrogen is mineralized over a long period of time. Perennial crops will be supplied with nitrogen during the year. This may result in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue, and make plants more susceptible to winter injury. The practice of putting manure around newly planted vines is not recommended because of potential winter injury problems.

pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. To determine pH, take a soil sample. For information on soil sampling, refer to *Soil Testing* on page 23.

Always take a soil sample before establishing a new planting. If lime is required, incorporate it during soil preparation. In established vineyards a soil sample in the vine row is recommended every 3 yr to ensure the pH is at a satisfactory level. If pH is low (acidic), apply lime to the sod cover in the fall, or before cultivation in the spring. The results will not be immediately evident because lime moves slowly into the soil.

The preferred pH before establishing a new vineyard is 6.5 on sandy soils and 6.0 on clay soils. If the pH in established vineyards is above 5.6, lime is not needed. Apply lime to established vineyards when the pH on clay loam soils drops below 5.1, and on sandy soils is below 5.6. Lime raises the soil pH, reducing its acidity and also supplying calcium. Use dolomitic lime (high in magnesium) on soils low in magnesium. Rates of application vary with soil type and initial pH. The buffer pH indicates the rate of lime to apply. For information on lime, refer to *Soil Acidity and Liming* on page 26.

Petiole Analysis for Grapes

In established plantings, petiole analysis in grapes is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop. Soil analysis is used in conjunction with petiole analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests consult *Plant Analysis* on page 25.

Nutrient uptake is affected by many vineyard conditions. Consequently, each year the nutrient levels will vary slightly depending upon the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the petioles and the relative amounts must be balanced.

TABLE 9–1. Nutrient Level Range (% Dry Weight) of Grape Petioles
(taken in September from mature vines)

Petiole Analysis	Nitrogen Low if below	Nitrogen High if above	Potassium* Low if below	Potassium* High if above	Magnesium Low if below
GRAPE					
Vinifera	0.8	1.4	1.2	2.3	0.6
Fredonia	0.6	1.2	0.8	1.8	0.6
Other cultivars	0.7	1.3	1.0	2.0	0.6

* Potassium levels will be higher with grapes grown on sandy loam soils.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

For petiole analysis to be most effective, sample the same vines each year. Make adjustments to the fertilizer program on the basis of this petiole analysis. For nutrient level ranges determined by petiole analysis, consult Table 9–1, *Nutrient Level Range of Grape Petioles.*

Fertilizer requirements are adjusted to the system of soil management, vine age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour, and storage quality must also be considered in determining the fertilizer required.

Fertilizer for Grapes

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Nutrient levels in the topsoil considered to be adequate for vineyard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium, and 1,000–5,000 ppm calcium. Table 9–2, *Phosphorus and Potassium Requirements for Grapes*, provides information on fertilizer rates prior to planting.

If the soil has been properly prepared, including deep cultivation and addition of organic matter, there should be an adequate supply of other nutrients to sustain the vine in the juvenile years. On coarse-textured, infertile soils, the use of a starter solution at planting time (e.g., 10-52-10 or 20-20-20) may give the vines a needed boost. High nitrogen levels can result in excessive growth and incomplete vine hardening. The use of cover crops to check late season growth in cultivated vineyards is strongly recommended, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil and in this way have the desirable effect of checking vine growth.

TABLE 9–2. Phosphorus & Potassium Soil Requirements Before Planting Grapes

Soil Phosphorus	New plantings of grapes	Soil Potassium	New plantings of grapes
Soil Test (ppm P)	Phosphate (P_2O_5) req'd kg/ha	Soil Test (ppm K)	Potash (K_2O) req'd kg/ha
0–3	80 L		
4–5	60 L	0–15	270 L
6–7	50 L	16–30	270 L
8–9	40 M	31–45	270 L
10–12	20 M	46–60	270 L
13–15	0 H	61–80	270 L
16–20	0 H	81–100	270 L
21–25	0 VH	101–120	270 L
26–30	0 VH	121–150	270 M
31–40	0 VH	151–180	270M
41–50	0 VH	181–210	270 M
51–60	0 VH	211–250	270 H
61–80	0 E	250 +	270H
80 +	0 E		

* For established grapes, plant analysis is used to estimate requirements of N, P + K

Nitrogen (N)

Petiole analysis is the most accurate way to determine nitrogen requirements of grapes. For information on this test, consult *Soil Testing* on page 23 and *Plant Analysis* on page 25. In the absence of such information, 34 kg N/ha is usually sufficient for most cultivars. This nitrogen is best broadcast before the 1st cultivation or applied as early as possible in the spring in sod vineyards. Nitrogen application can be reduced or eliminated if manure is used or growth has been excessive. For more information on manure, refer to *Manure for Vineyards* on page 129. Consult Table 9–1 for petiole analysis values. Foliar applications of nitrogen should be considered in some years, based on vine performance and petiole analysis.

If, because of severe winter temperatures, there has been fruit bud damage, it may be necessary to split applications. Apply the 1st application in mid-Apr. and the 2nd application, if necessary, after bloom in late May. Excessive spring rains can leach away spring applied nutrients. Apply additional fertilizer or foliar sprays after bloom. During dry springs, irrigation may be necessary to move the fertilizer into the rooting zone of the soil just before 1st bloom or immediately after petal fall.

Phosphorus (P)

Phosphorus is not required in large amounts by grapes. With few exceptions, the level of phosphorus in Ontario soils is presently adequate. Phosphorus does have a place for sod or cover crop maintenance. A soil test is the best way to determine if there is a need to apply this nutrient to the sod cover. In the absence of a soil test, a complete fertilizer (100 kg/ha 10-20-20) could be broadcast and incorporated before seeding a cover crop in a vineyard. Apply phosphorus before planting a vineyard, when it can be thoroughly incorporated in the soil if a soil test indicates a need. Phosphorus soil test values between 12–20 ppm are considered adequate for vineyard establishment and production

Potassium (K)

An excess amount of potassium can lead to deficiency of magnesium (Mg); avoid unnecessary potassium applications. Grapes require a larger quantity of potassium than tree fruits. In the absence of petiole analysis, 400 kg/ha of muriate of potash (0-0-60) every 2nd year on clay soil and 200 kg/ha every year on sandy soil may be adequate.

In cultivated vineyards, broadcast potassium before the 1st cultivation in the spring. With grapes on clay soils, apply potassium in a band to reduce potassium fixation in the soil. Potash can injure roots and trunks if applied too closely to the trunk.

Foliar application of potassium for grapes

In dry growing seasons potassium is not readily available to the plant. Where a potassium deficiency has been confirmed, foliar applications of potassium may be beneficial. Foliar potassium applied at veraison may improve fruit yield and quality.

Magnesium (Mg)

Magnesium deficiency is becoming more evident in vineyards, particularly when high rates of potash are used.

Magnesium deficiency can lead to premature fruit drop at harvest. Magnesium deficient vines have older leaves that are pale in colour, as magnesium is a part of the chlorophyll molecule. Petiole analysis is the best way to evaluate magnesium levels.

Foliar sprays of magnesium have been effective in correcting this deficiency for the current year only. For more permanent correction, soil applications of magnesium may be required. Magnesium soil test values between 100–250 ppm are considered adequate for grapes. See Table 9–3, *Magnesium Foliar Sprays*, on page 132.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. It is best to apply magnesium sulfate separately or try it on a few plants first. Check manufacturer's label regarding mixing magnesium chelates[1] with pesticides.

For long-term corrections, soil application of magnesium can be made. The response will not likely be immediate. Also, on some soil types a single, early-spring application of soil applied magnesium has not worked well. A 2nd or 3rd application the following spring may be required before the magnesium level in the plant improves. Foliar sprays are recommended for the first 2 yr, in addition to soil applications.

Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply magnesium.

Calcium (Ca)

Calcium deficiency has been associated with stem and bunch breakdown of Canada Muscat and Himrod grapes. Some formulations of calcium chloride ($CaCl_2$) have resulted in poor fruit finish if applied too

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[1] Use chelates recommended for foliar sprays.

TABLE 9–3. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced10 days apart beginning in mid July	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet plant to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

close to harvest. Calcium sprays must contact the fruit for uptake to be effective. Apply adequate water volume to wet the entire vine. The more calcium applied, the better the control; but high concentrations can cause foliar burning. Use $CaCl_2$ (77% flakes) at 4 kg/1,000 L of water from early July to mid Aug. Apply 3 sprays, 10–12 days apart. Do not apply calcium formulations containing nitrogen after the end of July or fruit quality may suffer.

For all the formulations, be sure to consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of 4, or more, sprays. Calcium sprays may damage foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Micronutrients for Grapes

Deficiencies of micronutrients or trace elements are not widespread in Ontario plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Only apply the nutrient that is deficient and in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency can have an effect on growth and fruiting. There is currently no accredited soil test for boron in Ontario. Use a petiole analysis to check for boron deficiencies. Boron levels should be 20–60 ppm. Where a boron deficiency has been confirmed, soil or foliar applications of boron may improve boron in plant tissues. There are several sources of boron. Check the manufacturer's recommended rates and timing of applications.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit-growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, soil tests can be used to determine the status of manganese in the soil. OMAFRA soil manganese index values greater than 8 should provide adequate manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate. Use manganese sulphate with a spreader sticker. Soil applications of manganese are not effective. Consult manufacturer's label for complete information on rates and timing.

Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the plant is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a petiole analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates[1] have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

Zinc (Zn)

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch die back. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes". This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to petiole analysis, soil tests can be used to determine the status of zinc in the soil. An OMAFRA soil zinc index value greater than 8 provides adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

Warning: Do Not Concentrate Nutrient Sprays

Visit the grape page on the OMAFRA Web site at www.gov.on.ca/OMAFRA/english/crops/hort/grape.html

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[1] Use chelates recommended for foliar sprays.

Grape Calendar

Read the label and follow all safety precautions.
Some grape varieties are sensitive to Sulphur, Thiodan, Copper, Dikar, or Dikar plus Zolone.
See Table 9–4 on page 139 for specific information.

To delay development of resistance to NOVA do not apply in consecutive applications and never apply more than 3 times/season. Do not use below label rates.

Avoid repeated applications of pyrethroids, such as Cymbush and Pounce. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 41 for more information.

Many processors may need longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Some processors also have special restrictions for certain pest control products, for example, number of applications or no application after a certain crop stage. Consult the contract purchaser of your grapes for more details.

Where the label allows, the pesticide rates/ha have been calculated based on water volumes that reflect changes in canopy development during the season. Calculations are based on dilute water volume guidelines of:

- 1700 L/ha during the period of shoot development up to "Inflorescence fully developed with floret separation"
- 2200 L/ha for "End of flowering to fruit set"
- 2800 L/ha at full canopy development at "Berries — Pea Sized". (Assume full rate of product/ha at this time).

While these water volumes may be larger than what is used today with modern sprayers, further adjustments of pesticide rates are not recommended. Reducing pesticide rates/ha below those listed in this publication may result in poor pest control and contravene manufacturer liabilities for performance.

Diseases and Insects	Materials	Amount/ha	Comments
First Leaf, 1.25–5.0 cm shoot length (amounts/ha based on dilute water volume of 1700 L/ha)			
Phomopsis cane and leaf spot	• Captan 80 WDG	2.00 kg	Begin spraying susceptible varieties early where there has been a history of phomopsis and conditions are wet. Apply in high water volume to ensure complete coverage.
	or [5]Maestro 80 DF	2.00 kg	
	• Folpan 50 WP	3.50 kg	
3–5 Leaves Unfolded, 10–15 cm shoot length (amounts/ha based on dilute water volume of 1700 L/ha)			
Phomopsis cane and leaf spot	• Captan 80 WDG	2.00 kg	Begin spraying susceptible varieties early where there is a history of phomopsis and conditions are wet. Apply in high water volume to ensure complete coverage.
	or [5]Maestro 80 DF	2.00 kg	
	• Folpan 50 WP	3.50 kg	
Black rot	• Nova 40 W	200 g	
	• Ferbam 76 WDG	3.50 kg	
	• Benlate T-N-G	1.00 kg	
Powdery mildew	• Nova 40 W	200 g	This spray is important to protect expanding leaves and developing fruit clusters from infections. Intervals between sprays need to be about 7–10 days. Under rainy conditions, intervals may need to be shortened to 7 day intervals. Do not use Nova more than 3 times/season.
	• [4]Dikar	5.50 kg	
	• Sulphur 92 WP	7.50 kg	
	or Kumulus 80 DF	7.10 kg	
	• Benlate T-N-G	1. 00 kg	

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Shoot Length, 20–25 cm (amounts/ha based on dilute water volume of 1700 L/ha)			
Phomopsis cane and leaf spot	• Captan 80 WDG	2.00 kg	Begin spraying susceptible varieties early where there is a history of phomopsis and conditions are wet. Apply in high water volume to ensure complete coverage.
	or [5]Maestro 80 DF	2.00 kg	
	• Folpan 50 WP	3.50 kg	
Black rot	• Nova 40 W	200 g	
	• Ferbam 76 WDG	3.50 kg	
	• Benlate T-N-G	1.00 kg	
Downy mildew	• [2]Ridomil Gold MZ 68WP	2.50 kg	If bloom is delayed or if wet weather is expected, repeat this application. Ridomil Gold MZ may be used only once/ season and only prior to bloom.
	• Dithane M45	3.40 kg	
	or Manzate 200 WP	6.75 kg	
	• [4]Dikar	5.50 kg	
	• Polyram DF	3.50 kg	
	• [5]Maestro 80 DF	2.00 kg	
	or Captan 80 WDG	2.00 kg	
	• Folpan 50 WP	3.50 kg	
	• [4]Gavel 75 DF	2.25 kg	
Powdery mildew	• Nova 40 W	200 g	This spray is important to protect expanding leaves and developing fruit clusters from infections. Intervals between sprays need to be about 7–10 days. Under rainy conditions, intervals may need to be shortened to 7 day intervals. Do not use Nova more than 3 times/ season and do not use in consecutive applications.
	• [4]Dikar	5.50 kg	
	• Sulphur 92 WP	7.50 kg	
	or Kumulus 80 DF	7.10 kg	
	• Benlate T-N-G	1.00 kg	
Inflorescence Fully Developed (flower cluster with floret separation) (amounts/ha based on dilute water volume of 1700 L/ha)			
Grape berry moth (1st generation)	• [4]Guthion Solupak	2.10 kg	Where there is a history of early season grape berry moth injury, applying an insecticide for 1st generation may be economically beneficial. Apply in high water volumes to ensure complete coverage. **Mating Disruption:** Vineyard block treated with either product must be larger than 2 ha for treatment. **i) Isomate GBM:** Apply Isomate GBM in late April or early May prior to flight and mating of grape berry moth (GBM) adults.
	or [4]Guthion 240 SC	4.25 L	
	or [4]APM 50 W	2.10 kg	
	or [4]Sniper 50 W	2.10 kg	
	• Isomate GBM	1,000 dispensers	
	• 3M Sprayable Pheromone	75 mL	**ii) 3M Sprayable Pheromone:** Apply the 1st application of 3M Sprayable Pheromone for GBM control in late April or early May, prior to 1st capture of moths in pheromone-baited traps. Delayed application results in increased mating and reduced control. The capture of moths in traps should remain at or near zero after application. Reapply at 14–21 day intervals during adult flight periods to ensure continued mating disruption of GBM. Isomate GBM and 3M Sprayable Pheromone are specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is being adequately controlled and to determine if special sprays are necessary for other sporadic pests such as leafhoppers. For more information see *Mating Disruption Technology (MD) for Grape Berry Moth* on page 140.
	• Imidan 50 WP	1.90 kg	
	• Diazinon 50 W	1.70 kg	
	• Sevin XLR Plus	5.25 L	
	• Cymbush 250 EC	240 mL	
	• Pounce	360 mL	
Downy mildew	• [2]Ridomil Gold MZ 68WP	2.50 kg	If bloom is delayed or if wet weather is expected, repeat the application. Ridomil Gold MZ may be used only once per season and only prior to bloom. This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to downy mildew during bloom to pea-sized berries.
	• Dithane M45	3.40 kg	
	or Manzate 200 WP	6.75 kg	
	• [4]Dikar	5.50 kg	
	• Polyram DF	3.50 kg	
	• [5]Maestro 80 DF	2.00 kg	
	or Captan 80 WDG	2.00 kg	
	• Folpan 50 WP	3.50 kg	
	• [4]Gavel 75 DF	2.25 kg	

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[1]Minimum period for re-entry is 4 hrs. [2]Minimum period for re-entry is 12 hrs. [3]Minimum period for re-entry is 24 hrs. [4]Minimum period for re-entry is 48 hrs. [5]Minimum period for re-entry is 72 hrs. [6]Minimum period for re-entry is 7 days.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	• Nova 40 W • [4]Dikar • Sulphur 92 WP or Kumulus 80 DF • Benlate T-N-G	200 g 5.50 kg 7.50 kg 7.10 kg 1.00 kg	This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to powdery mildew from bloom to pea-sized berries. Intervals between sprays over the bloom period should ideally be 7 days. Under rainy conditions, intervals may need to be shortened. Do not use Nova in consecutive sprays and no more than 3 times/season.
Black rot	• Nova 40 W • Ferbam 76 WDG • Benlate T-N-G	200 g 3.50 kg 1.00 kg	This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to black rot from bloom to pea-sized berries stage.

Do not apply insecticides while grapes are in bloom.
See *Bee Poisoning* on page 58.

End of Late Flowering to Early Fruit Set Stage (amounts/ha based on dilute water volume of 2200 L/ha)

Diseases and Insects	Materials	Amount/ha	Comments
Leafhoppers	• [4]Guthion Solupak or [4]Guthion 240 SC or [4]APM 50 W or [4]Sniper 50 W • Sevin XLR Plus • Diazinon 50 W • Cymbush 250 EC • Pounce	2.75 kg 5.50 L 2.75 kg 2.75 kg 6.00 L 2.20 kg 240 mL 175 mL	Grape leafhopper (GLH) and potato leafhopper (PLH) are the 2 main species of leafhoppers that feed on grapes. GLH causes pale white stippling along the veins. In some vineyards, Guthion or APM no longer give control of GLH. PLH feeding causes the leaves to yellow along the margins. Leaves cup upwards and later develop marginal necrosis. All products listed provide control of PLH.
Grape phylloxera (leaf form)	• Thiodan 50 WP or Endosulfan 50 W	2.20 kg 2.20 kg	Only French hybrid and vinifera varieties are susceptible to this pest.
Downy mildew	• Ridomil-Copper 70 WP plus Lime • Dithane M45 or Manzate 200 WP • [4]Dikar • Polyram DF • [4]Maestro 80 DF or Captan 80 WDG • Folpan 50 WP • [4]Gavel 75 DF	2.20 kg 3.50 kg 4.40 kg 6.75 kg 5.50 kg 4.50 kg 2.75 kg 2.75 kg 4.50 kg 2.25 kg	Spray all varieties for mildew at this time. Ridomil-Copper may cause injury to many varieties under cool, slow drying conditions. Do not use Ridomil-Copper mixtures in combination with other products; do not use more than 3 times/season.
Black rot	• Nova 40 W • Folpan 50 WP • Captan 80 WDG or [5]Maestro 80 DF • Polyram DF	200 g 4.50 kg 2.75 kg 2.75 kg 4.50 kg	
Powdery mildew	• Nova 40 W • Sulphur 92 WP or Kumulus 80 DF • [4]Dikar • Benlate T-N-G	200 g 10.00 kg 9.20 kg 5.50 kg 1.20 kg	This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to powdery mildew from bloom to pea sized-berries stage. Young developing fruit and leaves are very susceptible at this stage. It is important to maintain protectant coverage. Intervals between sprays should be 7 days. Under rainy conditions intervals may need to be shortened. Do not use Nova in consecutive sprays or more than 3 times/season.
Botrytis bunch rot	See comments for botrytis bunch rot control under **Berry Touch to Cluster Closure**.		

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Berries Pea-Sized (amounts/ha based on dilute water volume of 2800 L/ha)			
Grape berry moth (2nd generation)	• [4]Guthion Solupak	3.50 kg	Where berry moth is a regular problem, apply one of these materials in high water volumes to ensure complete coverage. **Mating Disruption:** Vineyard block must be larger than 2 ha for treatment. **i) Isomate GBM:** Apply 2nd application of Isomate GBM dispensers 60 days after 1st application (about late June or early July) but before significant 2nd flight of grape berry moth (GBM). **ii) 3M Sprayable Pheromone:** Apply 3M Sprayable Pheromone for grape berry moth (GBM) control before flight of second generation begins. Delayed application will result in increased mating and reduced control. Moth trap catches should remain at or near zero after application. Reapply at 14–21 day intervals during adult flight periods to ensure continued disruption of GBM. Isomate GBM and 3M Sprayable Pheromone are specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is being adequately controlled and to time special sprays for other sporadic pests such as leafhoppers. For more information see *Mating Disruption Technology (MD) for Grape Berry Moth* on page 140.
	or [4]Guthion 240 SC	7.00 L	
	or [4]APM 50 W	3.50 kg	
	or [4]Sniper 50 W	3.50 kg	
	• Isomate GBM	1,000 dispensers	
	• 3M Sprayable Pheromone	75 mL	
	• Imidan 50 WP	3.10 kg	
	• Diazinon 50 W	2.80 kg	
	• Sevin XLR Plus	6.40 L	
	• Cymbush 250 EC	240 mL	
	• Pounce	360 mL	
Phylloxera (leaf form)	Repeat as in **End of Late Flowering to Early Fruit Set Stage**.		
Powdery mildew	• Nova 40 W	200 g	Do not use Nova in consecutive sprays; alternate Nova and other effective products. Nova should not be used more than 3 times/season. These 2 points are key components in a resistance management strategy.
	• [4]Dikar	5.50 kg	
	• Sulphur 92 WP	12.60 kg	
	or Kumulus 80 DF	11.80 kg	
	• Benlate T-N-G	1.50 kg	
Downy mildew	• [4]Dikar	5.50 kg	Ridomil-Copper may cause injury to many varieties under cool, slow drying conditions. Do not use Ridomil-Copper mixtures in combination with other products. Do not use more than 3 times/season.
	• Folpan 50 WP	5.50 kg	
	• Captan 80 WDG	3.50 kg	
	or [5]Maestro 80 DF	3.50 kg	
	• Polyram DF	5.50 kg	
	• Dithane M45	5.50 kg	
	• Ridomil/Copper 70 WP	2.20 kg	
	plus lime	3.50 kg	
	• [4]Gavel 75 DF	2.25 kg	
Black rot	• Nova 40 W	200 g	For effective control, apply in high water volumes to ensure coverage.
	• Ferbam 76 WDG	5.60 kg	
	• Benlate T-N-G	1.50 kg	
	• Folpan 50 WP	5.50 kg	
	• Captan 80 WDG	3.50 kg	
	or [5]Maestro 80 DF	3.50 kg	
	• Polyram DF	5.50 kg	
Berry Touch to Cluster Closure (amounts/ha based on dilute water volume of 2800 L/ha)			
Powdery mildew	• Nova 40 W	200 g	
	• Sulphur 92 WP	12.60 kg	
	or Kumulus DF	11.80 kg	
	• [4]Dikar	5.50 kg	
	• Benlate T-N-G	1.50 kg	

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[1] *Minimum period for re-entry is 4 hrs.* [2] *Minimum period for re-entry is 12 hrs.* [3] *Minimum period for re-entry is 24 hrs.*
[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Botrytis bunch rot	- Rovral - [4]Vangard 75 WG - [1]Elevate 50 WDG	1.50 kg 750 g 1.10 kg	Direct this spray at the fruiting zone. Many of the vinifera and vinifera hybrid varieties with tight clusters are susceptible to botrytis bunch rot e.g., Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Chancellor, and Seyval Blanc. These susceptible varieties may require more than 1 application during the bunch closure period. For Elevate use Agral 90 at 200 mL/1,000 L of water (0.02% v/v) with the product in the tank. Do not apply Elevate if rainfall is expected within 6 hr after application. Do not apply Vangard within 30 m of lakes, streams and ponds.
Resistance Management			
Take the following steps to avoid rapid development of fungicide resistance. **• Do not apply any product more than once in a season.** **• Never use the same product in consecutive sprays.** **• Do not reduce label rates.**			**To maximize the effectiveness of all products:** **• Direct the spray to the fruiting zone of the grape canopy.** **• Use at least 1,000 L/ha of water or sufficient water to provide good coverage of the fruiting zone.** **• Apply as a separate spray.**
Mites	- [3]Pyramite - Kelthane 50 W	300 g 2.00 kg	A miticide may be required if the total number of active stages of European red mites (ERM) and two-spotted spider mites (TSSM) exceeds 20–25 mites/leaf on stressed vines or 30–35 mites on healthy vines. Monitor 7–10 days after application to evaluate control of targeted mite species. Pyramite is most effective against active nymphal stages, not adults. Use either miticide only once/season and alternate if possible. One miticide/yr and alternating products is an effective resistance management strategy.
Beginning of Ripening (veraison period) **(amounts/ha based on dilute water volume of 2800 L/ha)**			
Grape berry moth	- 3M Sprayable Pheromone	75mL	Applications for control of 2nd and 3rd generation should be continuous over the period of adult flight. Delayed application will result in increased mating and reduced control. Moth trap catches should remain at or near zero after application. Reapply at 14–21 day intervals during adult flight periods to ensure continued disruption of GBM. For more information see *Mating Disruption Technology (MD) for Grape Berry Moth* on page 140 and refer to comments for GBM at *Berries Pea-Sized*, page 137.
Grape berry moth about Aug. 20	Use one of the materials listed under **Berries Pea-Sized**		Check the interval to harvest. A spray may be needed on late varieties to control the brood which emerges in late Aug. Border sprays of conventional insecticides may be very effective. For 3M Sprayable Pheromone, spray the entire block.
Powdery mildew	Use one of the materials listed under **Berry Touch to Cluster Closure**. Check for interval to harvest.		Vinifera and French hybrid varieties are more susceptible and may require extra sprays. Do not use Nova as an eradicant when powdery mildew is already a severe problem. For good resistance management, do not use Nova at this time.
Downy mildew	Use one of the materials listed under **Berries Pea-Sized.**		Ridomil-Copper may cause injury to many varieties under cool, slow drying conditions. Do not use more than 3 times/season. Ridomil-Copper mixtures should not be used in combination with other products.

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[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Botrytis bunch rot	• [4]Vangard 75 WG • [1]Elevate 50 WDG • Rovral	750 g 1.10 kg 1.50 kg	In years when late summer or fall weather conditions are wet and humid, additional sprays to protect against botrytis may be necessary during the ripening or veraison period. This is especially important for vineyards designated for late harvest or ice wine. For further information on product choice and use, see comments under **Berry Touch to Berry Closure**.
Postharvest			
Hardening-off vines	• Copper sulphate plus Lime • Copper 53 WP plus Lime	4 kg/1,000 L 6 kg/1,000 L 3 kg/1,000 L 6 kg/1,000 L	Some premature defoliation may be observed, but is not likely to affect vine vigour. Rates for copper and lime are given as rates/1,000 L of water. Postharvest applications of copper assist in maturing the new wood which often helps increase the winter hardiness of canes. 2 applications or more may be necessary in high vigour and/or young plantings. Use sufficient water volume to ensure complete coverage of the vine. See *Use of Copper Products on Fruit Crops* on page 51 for information on how to mix copper sprays.

Use this table as a guide, but refer to product label for specific information.

TABLE 9–4. Days to Harvest Intervals for Products Used on Grapes

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
APM 50W INSTAPAK	28	FERBAM 76 WDG	7	POLYRAM DF	45
BENLATE T-N-G	7	FOLPAN 50 WP	1	POUNCE	21
CAPTAN 80 WDG	7	GAVEL 75 DF	66	PYRAMITE	25
COPPER 53W	1*	GUTHION 240 SC	28	RIDOMIL-COPPER	66
CYMBUSH 250 EC	7	GUTHION SOLUPAK	28	RIDOMIL GOLD MZ	PB
DIAZINON 50W	16	IMIDAN 50 WP	7	ROVRAL	7
DIKAR	30	KELTHANE 50 W	7	SEVIN XLR PLUS	5
DITHANE M-45	30	KUMULUS DF	21**	SNIPER 50W	28
DZN 600 EW	16	MAESTRO 80 DF	7	SULPHUR	21**
ELEVATE 50 WDG	7	MANZATE 200 WP	30	THIODAN 50 WP	30
ENDOSULFAN 50W	30	NOVA 40W	14	VANGARD 75 WG	7

PB: prebloom

* check with processor for wine grapes

** 21 days of wine grapes. 1 day for table grapes

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[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Grape Insect Control

Mating Disruption Technology (MD) for Grape Berry Moth

Many adult insects, usually females, emit volatile chemicals known as sex pheromones to attract members of the opposite sex. When a female moth secretes these chemicals, males respond to the pheromone trail or "plume", using it to pinpoint her location. Synthetically produced sex pheromones have been successfully used for decades to monitor insect activity patterns.

Mating disruption technology uses these same chemicals to confuse males and limit their ability to locate pheromone emitting ("calling") females. The release of sufficiently large quantities of synthetic sex pheromone into the crop environment interferes with mate location by masking the trail or pheromone plume emitted by the female moth. The probability of the male finding the female is reduced, along with the likelihood of successful mating. As a result, mating is either delayed or prevented. The subsequent population is reduced, and fewer larvae are present to cause crop damage.

In Canada, there are presently 2 registered pheromone products available for the control of the grape berry moth — Isomate GBM and 3M Sprayable Pheromone for Grape Berry Moth. To control the grape berry moth (GBM) with Isomate GBM, pheromone dispensers are placed uniformly through the vineyard. 3M Sprayable Pheromone for GBM can be applied using conventional spray equipment. The resulting high concentration of pheromone makes it difficult for male moths to locate female moths within the crop canopy.

The advantages of MD technology include:

- **Pest specificity**. Since synthetic pheromones are not harmful to non-target organisms, populations of beneficial mites and insects may increase.

- **Low toxicity**. Pheromones are non-toxic and present a much lower hazard to farm workers.

- **Resistance management**. MD reduces pressure for development of insect resistance to pesticides. MD is readily incorporated into IPM programs.

- **Efficacy**. When applied as directed, control rates are comparable or superior to those obtained using conventional products.

- **Timing**. Fixed-point dispensers are applied 1–2 times/ season, depending upon the formulation and dispenser. Their effectiveness does not depend on weather conditions. Sprayable formulations can be applied using conventional equipment prior to moth flight of each generation. Apply both products as directed on their respective labels.

Insect monitoring, sampling and damage assessments must be carried out throughout the season to ensure that GBM is being adequately controlled and to determine if special sprays are necessary for other sporadic pests such as leafhoppers, mites, and spring feeding caterpillars. **Regular monitoring is critical to the successful implementation of any IPM program.**

Choosing a Site for Mating Disruption

Vineyards should be at least 2 ha in size. Mating disruption works best in vineyards with low insect populations. Avoid vineyards located next to vineyards with known high populations of grape berry moth.

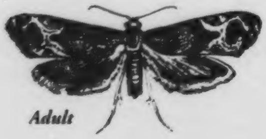
Application of Pheromone

It is critical that synthetic pheromones be applied prior to, or at the onset of, moth emergence. Delayed application results in increased mating and reduced control.

Apply **fixed-point dispensers** such as Isomate GBM manually in late April or early May prior to 1st spring flight of moths. Make 2 applications of pheromone dispensers/season at the manufacturer's recommended rate. Attach dispensers securely to the upper training wire close to the vines. Dispensers must be applied throughout the vineyard in sufficient numbers to achieve an adequate release of synthetic pheromone throughout the field. Wear gloves when applying pheromone dispensers to avoid cross-contamination with other pheromone products. Make the 2nd application of pheromone approximately 60 days later (i.e. July 15–Aug. 1), or as indicated on the product label.

Sprayable formulations must also be applied prior to significant moth activity. Apply **sprayable pheromone** following 1st moth catch, as indicated by pheromone monitoring traps. The capture of moths in traps should remain near zero after application. To ensure continued mating disruption of GBM, reapply at 14–21 day intervals or as indicated by the product label. Sprayable formulations must be reapplied for each new generation.

Monitoring for Grape Berry Moth


Adult

Use 5 pheromone traps for vineyards up to 5 ha in size. Place traps along a line that transects the vineyard. In addition, place at least 1 extra trap along the windward edge of the vineyard. Where vineyards are located adjacent to wooded areas, place traps within the border area, at least 40 m apart. Bait the traps with commercial lures available from local distributors. Inspect traps every 3–4 days and record the number of moths. Replace lures every 4 weeks. Captures of moths in pheromone traps should be very low to zero. If more than 2 moths/5 traps in total are caught during a flight period of a generation, apply supplemental insecticides, using the appropriate timing.

Inspect vineyards weekly for signs of fruit infestation. Make the inspections along a transect. In addition, carefully inspect border areas, especially those on the windward side, for signs of fruit infestation. If more than 5% of the grape clusters are infested with grape berry moth larvae, apply supplemental insecticides using the appropriate timing.

Mating disruption technology prevents mating of grape berry moth adults. However, if mated female moths of this species are present in adjacent areas, migration of these moths into a pheromone treated vineyard reduces the level of control achieved. Sources of mated females are likely to be unsprayed vineyards or wild grapevines within 100 m of the treated vineyard. Migration of mated females can be prevented by:

- treating entire blocks, not just sections of large conventionally treated fields, with pheromone dispensers
- treating sources of infestation with pheromone dispensers
- treating infestation source(s) with an effective insecticide and
- treating edges of vineyard with timely insecticide applications.

Grape Disease Control

Use of Nova 40 W on Grapes

Nova is a member of the SI (sterol inhibitor) group of fungicides. It must be used differently from the "protectant" fungicides such as captan or mancozeb.

SI fungicides are systemic and must be absorbed by the leaf and fruit tissue to be effective. Nova is absorbed within 1 hr of application, and effectiveness is not reduced if rain occurs more than 1 hr after application.

Nova does not redistribute well after application. Therefore, uniform spray coverage is essential for good disease control.

Nova gives good control of powdery mildew and black rot, but not downy mildew or botrytis bunch rot. If downy mildew control is required, combine Nova with Dithane M-45, which controls downy mildew. The maximum number of applications/season is 3, beginning at prebloom.

Crown Gall Disease of Grapevine

Crown gall, caused by the bacterium *Agrobacterium vitis*, (*A. vitis*), is a serious problem where grapes are grown in climatic conditions that favour freeze injury. Severely diseased vines usually exhibit significant reductions in yield and vigour, predisposing them to winter kill.

Cultural Practices for Crown Gall Control

Use best available nursery stock. Latently infected nursery stock is the major source of infection. Grafting wood from warm climates often harbours the pathogen that induces crown gall symptoms in vines grown in cooler climates. Hot water treatment of nursery stock prior to grafting significantly reduces levels of crown gall infection. At present, no commercially- available crown gall-free certified nursery stock is available in Canada, although several nurseries are evaluating heat treatment.

Use the following management practices to reduce injury, since crown gall is closely correlated with the occurrence of injury.

- For new plantings, **select sites with good soil and air drainage** not prone to freeze injury.

- **Select hardy, cold tolerant cultivars where possible.** Do not plant cold sensitive varieties in marginal areas with poor soil drainage and exposure to cold temperatures.

- **Hill trunks in the fall** with soil to protect the crown from cold temperatures. This ensures new shoots for trunk renewal or replacement the following season.

- **Avoid injuring vines during cultivation**, since the soil inhabiting pathogen enters through wounds, particularly in spring and early summer.

Fallowing the land or planting other crops for several years reduces *A. vitis* in the soil. Infected roots left in the soil after vine removal are a reservoir of inoculum. These populations likely lead to greater persistence of the pathogen in the field. By using clean planting stock and managing soil populations of *A. vitis* you may provide effective control of crown gall because:

- *A. vitis* has not been detected in soils where grapevines have not been grown
- levels of soilborne *A. vitis* decline in the absence of grapevines
- low levels of *A. vitis* fail to increase around grapevine roots.

Train multiple trunks of differing ages to allow renewals to replace trunks killed by cold temperatures or by crown gall. This does not eliminate the pathogen, but it helps ensure a crop, allowing you to manage the disease at a tolerable level.

Topical chemical treatments are ineffective because the pathogen is systemic in the grapevine and new galls will develop around or beyond the treatment site. Soil fumigation is generally ineffective, particularly in heavier soils, but also in light-textured soils where roots often extend deeper than the fumigant application. The pathogen can remain viable in the soil as long as infected living grape root material is present.

Apply nitrogen in early spring. Avoid excessive rates. Vines that grow late in the season do not adequately harden-off and have a higher water content going into winter. These vines are more prone to winter injury and crown gall infection. Excessive N can cause rapid growth in the spring. This can cause bark splitting, which acts as entry points for infection.

When removing diseased vines from a vineyard, remove as much of the root system as possible before replanting. The significance of soil inoculum in replanted vineyards is poorly understood. Soil infection of newly planted vines can occur if sufficient amounts of the pathogen are present.

Ongoing research is focusing on developing a biological control agent for "immunizing" vines against crown gall disease. This would provide protection for clean nursery stock being planted into sites with a past history of crown gall disease. However, at present, no biological agents are commercially available to protect nursery stock against this disease.

Relative Disease Susceptibilities

Table 9-5, *Relative Disease Susceptibilities,* provides a relative rating of grape variety susceptibility based on observations in Ontario and northeast United States under average conditions. Under adverse weather conditions, for example, extended cool weather, any given variety may be more seriously affected.

TABLE 9–5. Relative Disease Susceptibilities

Blank = relative susceptibility is unknown
+ = slight susceptibility
++ = moderate susceptibility
+++ = highly susceptible

1 = Sulphur sensitive
2 = Dikar + Zolone combination may be phytotoxic
3 = Dikar sensitive
4 = Thiodan sensitive
5 = Copper sensitive

Cultivar	Type[a]	Eutypa dead arm	Phomopsis cane blight	Black rot[b]	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity[c]
Vinifera Wine								
Auxerrois	V		++		+	+++	+++	
Cabernet Franc	V		++	+++	++	+++	+	
Cab. Sauvignon	V	++	++	+++	++	+++	+	
Chardonnay	V	+	++	+++	++	+++	++	3
Gamay	V	+	+	+	++	+++	++	
Gewurztraminer	V	++		+++	++	+++	+++	
Kerner	V				+++	++	+	
Merlot	V		+	++	++	+++	+	5
Pinot Blanc	V			+++	++	+++	+++	
Pinot Gris	V			+++	++	+++	+++	
Pinot Noir	V			+++	++	+++	+++	
Riesling	V	+	+	+++	++	+++	+++	
Sauvignon Blanc	V			++	++	++	+++	5
Scheurebe	V				+	+++	+	
Zweigeltrebe	V		++	+++	++	+++	+	
Hybrid Wine								
Baco Noir	FH		++	+	+	++	+	4
Chambourcin	FH		+	++	++	++	+	1,4
Chancellor	FH		+	+	+++	+++	++	5
Chelois	FH	+++	++	++	+	+++	++	3
Couderc Muscat	FH			++		+++	+	
De Chaunac	FH	+	+++	+	+	++	+	1
Foch	FH	++	++	+	+	++	+	1,2,3
J.S.23-416	FH		+			++		
Rosette	FH		++	++	+++	++	+	
Seyval Blanc	FH		++	++	++	+++	+++	
S.V. 23-512	FH		+			++		
Vidal 256	FH		+	+	++	++	+	5
Ventura	AH	++	++	++	++	++		
Villard Noir	FH		+			++	+	3, 4
Juice & Table								
Agawam	L	+	++	+++	+++	++		
Canadice	AH			+++	+	+	++	
Concord	L	+	++	++	++	++	+	1,4,5
Elvira	L	+++	+++	++	+	++	++	5
Festivee	AH				+	+++	++	
Fredonia	L	+	++	++	+++	++	+	
Himrod	AH		+	++	+	++		
N.Y. Muscat	L	+		+	+	++	+	
Niagara	L	++	++	+++	+++	++	+	5
Sov. Coronation	L		+			+		
Van Buren	L	+			+++	++		1
Vanessa	AH		+	+++	++	++	+	

a = Species type
b = Black rot is more serious adjacent to bush or similar areas with poor air drainage.
c = These notes are based on grower experience and could vary under stress conditions.

L = labrusca
AH = American hybrid
FH = French hybrid
V = Vinifera (vinifera varieties not included in this chart are considered susceptible to powdery mildew)

TABLE 9–6. Effect of Fungicides on Grape Diseases*

0 = ineffective
+ = slightly effective
++ = moderately effective
+++ = very effective

Fungicide	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot
Benlate T-N-G	+	++	0	+++	0
Captan 80 WDG	+++	++	+++	0	+
Copper-Lime	+	++	++	++	0
Dikar	+	+++	+++	+++	0
Dithane M-45	+	+++	+++	0	0
Elevate 50 WDG	0	0	0	0	+++
Ferbam 76 WDG	+	+++	++	0	0
Folpan 50 WP	+++	++	+++	+	+
Gavel 75DF	?	?	+++	0	?
Kumulus DF	0	0	0	+++	0
Manzate 200 WP	+	+++	+++	0	0
Nova 40 W	0	+++	0	+++	0
Polyram DF	?	+++	+++	0	0
Ridomil Gold MZ	?	?	+++	?	?
Ridomil-Copper plus Lime	?	?	+++	?	?
Rovral	0	0	0	+	+++
Sovran	+	+++	++	+++	+
Sulphur	0	0	0	+++	0
Vangard 75 WG	0	0	0	0	+++

* Use fungicides only for diseases listed on the product label.

10. Tender Fruit (Stone Fruit and Pears)

Tender Fruit Nutrition

It is important to prepare and test soil before planting trees. To ensure long-term productivity of these perennial crops prepare the soil through tillage and adding organic matter, well in advance of planting. For information on building and maintaining soil organic matter see *Managing Soil Organic Matter* on page 28 and *Manure for Orchards* below.

Prior to planting, ensure that nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to *Fertilizer for Non-Bearing Tender Fruit* on page 146. Preplant applications of phosphorus, potassium and lime are the most effective.

Manure for Orchards

A spring application of manure can be beneficial in providing nutrients and organic matter to established orchards. However, see *Food Safety Concerns with Manure Application and Timing* on page 31. Manure is of more benefit in cultivated orchards, compared to those in permanent sod, because manure can be easily worked into the soil, making it available to the tree roots. You can also apply manure in the fall to provide nutrients and organic matter prior to spring planting.

Broadcast manure at no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 t/ha of cattle (100 m^3 liquid), or 35 t/ha hog (65 m^3 liquid). As manure is extremely variable in nutrient content, be sure to analyze it before applying. When using manure, reduce the rate of fertilizer. Table 3–5, *Average Amounts of Available Nutrients for Different Types of Manure*, on page 29 shows the average composition of some manures and suggested reduction in fertilizer if using manure.

Nitrogen in manure becomes available over a long time. Perennial crops that have manure applied continue to be supplied with nitrogen during the year. This can be a disadvantage, resulting in:

- poor fruit colour
- excessive terminal growth
- delayed hardening of the woody tissue
- increased susceptibility to winter injury.

Do not place manure around newly planted trees because of potential winter injury problems.

pH Requirements for Tender Fruit

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. Take a soil sample to determine its pH. For information on soil sampling, consult *Soil Testing* on page 23.

Always take a soil sample before establishing a new planting. If lime is required, incorporate it during soil preparation. In established orchards, a soil sample in the tree row is recommended every 3 yr to ensure the pH is satisfactory. If pH is low (acidic), apply lime to the sod cover in the fall, or before cultivation in the spring. The results will not be immediately evident because lime moves slowly into soil.

The preferred pH before establishing a new orchard is 6.5 on sandy soils and 6.0 on clay soils. If the pH in established orchards is above 5.6, lime is not needed. Apply lime to established orchards when the pH on clay loam soils drops below 5.1, and on sandy soils below 5.6. Applying lime to a soil reduces its acidity by raising the pH. It also supplies calcium. Use dolomitic lime (high in magnesium) on soils low in magnesium.

TABLE 10–1. Nutrient Level Range (% Dry Weight) of Mid-Shoot Leaves (taken last 2 weeks of July from mature trees)

	Nitrogen*		Potassium		Magnesium
Leaf Analysis	Low if below	High if above	Low if below	High if above	Low if below
PEACH	3.4	4.1	2.3	3.5	0.35
PEAR	2.0	2.6	1.2	2.0	0.25
CHERRY					
Montmorency	2.2	3.0	1.3	2.5	0.35

* Leaf nitrogen in non-bearing trees should be 0.2% higher.

Rates of application vary with soil type and initial pH. The buffer pH determines the rate of lime to apply. For information on lime, consult *Soil Acidity and Liming* on page 26.

Leaf Analysis for Tender Fruit

In established plantings, leaf analysis for tender fruit is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests consult *Plant Analysis* on page 25.

Nutrient uptake is affected by many orchard conditions. Consequently, each year nutrient levels vary slightly depending upon the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the leaves and relative amounts must be balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAFRA Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. For nutrient ranges of pears, peaches and tart cherries leaf analysis, consult Table 10–1, *Nutrient Level Range of Mid-Shoot Leaves.*

Fertilizer requirements are adjusted to the system of soil management, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size and colour, and storage quality must also be considered in determining fertilizer required.

Fertilizer for Tender Fruit

Fertilizer for Non-Bearing Tender Fruit

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Nutrient levels in the topsoil adequate for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium, and 1,000–5,000 ppm calcium. Table 10–2, *Phosphorus and Potassium Soil Requirements before Planting Tender Fruits*, on page 147, provides information on fertilizer rates prior to planting.

If the soil has been prepared properly, including deep cultivation and addition of organic matter, there should be an adequate supply of other nutrients to sustain the tree in the juvenile years. On coarse-textured, infertile soils, the use of a starter solution at planting time (e.g., 10-52-10 or 20-20-20) may give the trees a needed boost. High nitrogen levels can result in excessive growth and incomplete tree hardening.

Use cover crops to check late season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and limit tree growth.

On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can occur if placed too close.

TABLE 10–2. Phosphorus and Potassium Soil Requirements before Planting Tender Fruits

Soil Phosphorus	New plantings of peaches, pears, plums, cherries*	Soil Potassium	News plantings of peaches, pears, plums, cherries*
Soil Test (ppm P)	Phosphate (P_2O_5) req'd kg/ha	Soil Test (ppm K)	Potash (K_2O) req'd kg/ha
0–3	80 L		
4–5	60 L	0–15	180 L
6–7	50 L	16–30	170 L
8–9	40 M	31–45	160 L
10–12	20 M	46–60	140 L
13–15	0 H	61–80	110 L
16–20	0 H	81–100	70 M
21–25	0 VH	101–120	40 M
26–30	0 VH	121–150	20 M
31–40	0 VH	151–180	0 H
41–50	0 VH	181–210	0 H
51–60	0 VH	211–250	0 VH
61–80	0 E	250 +	0 E
80 +	0 E		

* For established tree fruits, plant analysis is used to estimate requirements of N, P + K.

Fertilizer for Bearing Tender Fruit

Most bearing orchards require annual applications of both nitrogen and potassium fertilizer. These 2 elements significantly affect growth and productivity.

Do not apply nitrogen in excessive amounts. Late or excessive applications of nitrogen result in poor fruit colour and quality. Also, available nitrogen late in the season encourages the tree to grow instead of harden off, potentially leading to winter injury.

Using cover crops in cultivated orchards helps to lower the nitrogen level in the latter part of the season. Cover crops, such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil, thus limiting tree growth. In herbicide-treated strips under trees, weed growth late in the season takes up extra nitrogen, helping to harden off trees and improve fruit quality.

Nitrogen (N)

Nitrogen is necessary for many tree functions including growth, fruit bud formation, fruit set and fruit size. Cultivars differ in their nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also affect application rates. If pruning is to be severe, reduce nitrogen rates or eliminate it for a year. Tree growth, foliage colour and fruit colour, quality and storability, nutrient balance in leaves and soil, are also important considerations. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Do not apply urea (46-0-0) to sod orchards since some nitrogen is lost by volatilization. There are several forms of nitrogen available. If there has been fruit bud damage because of severe winter temperatures, it may be necessary to split applications. Apply the 1st application in mid April and the 2nd, if necessary, after bloom in late May. Excessive spring rains leach spring-applied nitrogen. Apply additional fertilizer or foliar sprays after bloom. During dry springs, irrigate to move the fertilizer into the rooting zone of the soil just before 1st bloom or immediately after petal fall.

For fire blight sensitive pear cultivars, use less than the maximum rate of N suggested.

For pear, peach, plum, and cherry orchards where leaf analysis is not available, the following rates are considered normal.

For each year of tree's age, apply between 30–40 g of N. Thus, a 5-year-old tree in sod culture requires 150–200 g of N. See Table 10–3, *Actual Nitrogen Rates per Tree in Sod Culture*, on page 148. The rate for cultivated orchards can be cut by half, as competition for nutrients is greatly reduced. Trees on dwarfing rootstock generally require more nitrogen/ha (not per tree) than trees on more vigorous stocks. When the tree canopy has covered the space available, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.

For all tree fruits do not exceed the maximum rates of 200 kg actual N/ha per year, even in cases of severe deficiency.

Nitrogen Placement and Timing

Apply nitrogen fertilizer in early April. In cultivated orchards broadcast nitrogen under the tree canopy. In sod orchards place the nitrogen in a band under the drip line or in the herbicide strip.

TABLE 10–3. Actual Nitrogen Rates per Tree in Sod Culture

	ACTUAL NITROGEN per TREE (grams)		
YEAR or TREE AGE	**Number of Trees/Ha (trees/ac)**		
	400 (160)	**500 (200)**	**600 (240)**
Planting Year	0	0	0
1	40	40	40
2	80	80	80
3	120	120	120
4	160	160	160
5	200	200	180
6	240	240	240
7	280	280	260
8	320	320	280
9	360	360	300
10	400	400	320
11	440	400	320
12	480	400	320

Foliar Application of Nitrogen for Tender Fruit

When weather or crop conditions create a need for additional nitrogen at a critical time, foliar applications of urea (46% nitrogen) have been successfully used on apples. Late applications adversely affect fruit quality and winter survival of the tree. Do not rely on foliar sprays to completely substitute for soil applications if nitrogen is required. There are several formulations of foliar N. In some years, make applications based on tree performance and leaf analysis.

Phosphorus (P)

Phosphorus is not required in large amounts by fruit trees. With few exceptions, the level of phosphorus in Ontario soils is adequate. Phosphorus does have a place for sod or cover crop maintenance. A soil test is the best way to determine if you need to apply this nutrient to sod cover. Without a soil test, a complete fertilizer (100 kg/ha 10-20-20) could be broadcast and incorporated before seeding a cover crop. If indicated by a soil test, apply phosphorus before planting an orchard when it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for fruit tree establishment and production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance (fire blight in pears). An excess amount of potassium can lead to deficiency of magnesium (Mg), so take care when deciding upon potassium rates. Potassium soil test values between 120–150 ppm are adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available the following rates can be considered normal.

Trees 1–6 Years of Age Regardless of Density

Apply 50 g K_2O (80 g muriate of potash) per 2.5 cm of trunk cross-section (diameter).

Trees 7 Years of Age or Older

Apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard tree in a year, regardless of how severe the deficiency. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.

Placement and Timing

You can apply potassium separately or combined with nitrogen in early spring. Some growers make fall applications because of time constraints in the spring. However, some of the potassium may be lost by leaching over winter. For this reason, apply in spring if possible. In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

Foliar Application of Potassium for Tender Fruit

In dry growing seasons potassium is not readily available to the plant. Foliar applications of potassium may help where potassium deficiency is confirmed.

Magnesium (Mg)

Magnesium deficiency is becoming more evident in orchards, particularly when high rates of potash are used.

Magnesium deficiency can lead to premature drop of fruit at harvest.

Trees deficient in magnesium have older leaves that are pale in colour, as magnesium is a part of the chlorophyll molecule. Leaf analysis is the best way to evaluate magnesium needs.

TABLE 10–4. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

Foliar sprays of magnesium are effective in correcting this deficiency for the current year only. For more permanent correction, soil applications of magnesium are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees. See Table 10–4, *Magnesium Foliar Sprays*.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate; therefore, apply magnesium sulfate separately or try it on a few trees first. Check manufacturer's label regarding mixing magnesium chelates[1] with pesticides.

For long-term corrections, apply magnesium to the soil, but the response will not likely be immediate. On some soil types a single early spring application of soil-applied magnesium has not worked well. A 2nd or 3rd application the following spring may be required before the magnesium level in the tree improves. To be sure that fruit drop is not a problem during this waiting period, foliar sprays are recommended for the first 2 yr, in addition to soil applications.

For soil corrections, apply 5–7 kg/mature standard tree, and 3–4 kg/mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer known by several trade names. It contains approximately 21% potash and 11% magnesium. This material is applied in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. No further potash (e.g. 0-0-60) is needed, but apply nitrogen at recommended rates. Other sources of magnesium also work well as a soil application. If magnesium is being blended with the fertilizer, apply at least 80 kg of available magnesium/ha when the fertilizer is spread. Use dolomitic limestone on acidic soils to raise the soil pH and to supply magnesium.

Calcium (Ca)

Lack of calcium is associated with fruit problems in pear, and gummosis in European plums and prunes. Some formulations of calcium chloride ($CaCl_2$) result in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective; therefore water volumes capable of wetting the entire tree are required. The more calcium applied, the better the control; however excessive calcium can cause foliar burning. Use $CaCl_2$ (77% flakes) at 4 kg/1,000 L of water from early July to mid-Aug. Apply 3 sprays, 10–12 days apart. Do not apply calcium formulations containing nitrogen after the end of July or fruit quality and storability may suffer.

For all formulations consult label directions for concentrations to use and compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of 4 or more sprays. Calcium sprays may injure foliage and fruit if applied during low temperature and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Micronutrients for Tender Fruit

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Only apply the nutrient that is deficient in sufficient quantities to correct the problem.

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[1] Use chelates recommended for foliar sprays.

Boron (B)

Boron deficiency is perhaps the most common of micronutrient deficiencies. It occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, or on sandy knolls. Boron deficiency has an effect on growth and fruiting.

There is currently no accredited soil test for boron in Ontario. Use a foliar analysis to check for boron deficiencies. Boron levels should be 20–60 ppm. Where a boron deficiency is confirmed, apply boron to soil or in foliar applications of boron to improve boron in plant tissues. There are several sources of boron. Check the manufacturer's recommended rates and timing of applications.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. In addition to leaf analysis, use soil tests to determine the status of manganese in the soil. OMAFRA soil manganese index values greater than 8 should provide adequate manganese to the crop. If manganese is required, apply as a foliar spray of manganese sulphate or chelate.[1] Use manganese sulphate with a spreader sticker. Soil applications of manganese are not effective. Consult manufacturer's label for complete information on rates and timing.

Manganese Toxicity

On some peach cultivars manganese toxicity can occur on coarse-textured soils when the soil is very acid (pH below 5.0). The symptoms known as "measles" are raised pimples on the bark underlain by dark brown spots. Other symptoms that may be observed are leaf chlorosis, tip dieback, early leaf abscission, reduced flower bud development and shoot growth. Correction is sometimes possible by adding lime to raise the soil pH. If possible, work into the soil. Prior to orchard planting, sample the soil and add lime if pH is low.

Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily-limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the tree is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a foliar analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates[1] have made correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

Zinc (Zn)

Zinc deficiency symptoms include short internodes, small narrow leaves, and interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. In addition to leaf analysis, soil tests can be used to determine the status of zinc in the soil. An OMAFRA soil zinc index value greater than 8 should provide adequate zinc to the crop. Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

Warning: Do not concentrate nutrient sprays.

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[1] Use chelates recommended for foliar sprays.

Stone Fruit Diseases

Sharka (Plum Pox Virus) of Stone Fruits

Sharka or Plum Pox Virus (PPV) is a serious disease of stone fruit. It has spread throughout many European countries resulting in significant economic losses. The "D" strain of Sharka has recently been found in several orchards in Ontario, Pennsylvania and one in Nova Scotia. This strain of Sharka can naturally infect most cultivated fruit tree species of the genus *Prunus* including apricots, common plum, Japanese plum, peach, nectarine, but not sweet and sour cherry.

The plum pox virus is locally transmitted from infected hosts to previously uninfected plants by aphids over short distances. Long distance spread of the virus is through the movement of diseased budwood and other propagation material by humans.

Symptoms vary and may not appear on infected trees for several years after infection. Symptoms may appear on only a few branches, leaves or fruit.

Leaf symptoms include light chlorotic or yellow rings, spots, blotches and line patterns often along veins, and vein clearing. Severely infected leaves may be twisted, curled and distorted.

Symptoms of PPV on peach and nectarine fruit first appear as faint mottled yellow lines, patches and rings on green fruit. As the fruit matures, the lines, patches and rings remain yellow surrounded by the normal red ripe colouration. Some fruit on the same infected tree may have no symptoms while other fruit are severely diseased. The sugar content is also affected in some cultivars.

Severely diseased plum and apricot fruit are pocked with dark, sunken rings and appear severely deformed. Rings and spots are occasionally seen on the pits of infected apricot fruit sometimes displaying no other external symptoms. In Europe, yield losses between 20%–30% have been reported on susceptible plum varieties.

Infected trees rarely die but frequently become less productive as the disease progresses. Fruit may drop 20–30 days prematurely depending on the host species, cultivar and PPV strain.

Sharka must be eradicated before it becomes established in stone fruit-producing regions. There are no commercially available varieties resistant to Sharka. Due to the ability of migrant aphids to quickly acquire and transmit the virus, insecticide applications to control aphids have not been effective in reducing the spread of disease. Insecticides to control aphids also reduce populations of beneficial insect predators and are not IPM compatible. A protocol to eradicate plum pox from Canada is currently being implemented by the Canadian Food Inspection Agency. The eradication protocol involves surveying orchards and nurseries regularly and immediately removing infected trees or entire orchard blocks before the virus spreads.

For more information see www.gov.on.ca/OMAFRA/english/crops/ hort/sharka/sharka.htm and OMAFRA Factsheet *Sharka (Plum Pox Virus) of Stone Fruit and Ornamental Species,* Order No. 02-001.

Brown Rot Control

Development of Resistance

Benlate and Senator are chemically-related fungicides. These products gave superior control of brown rot in the past. Frequent, and sometimes almost exclusive use of Benlate in the 1970s, resulted in the selection of Benlate-resistant forms of the brown rot fungus in many stone fruit orchards in the Niagara region. This type of resistance has remained quite stable in the field for the last 20 yr.

Benlate is recommended only in areas where resistance is not prevalent, and only as a tank-mixture with Captan. Captan provides some insurance against losses associated with the development of Benlate resistance. Do not use Benlate-Captan in orchards known to have Benlate-resistant strains of the fungus because Benlate would be largely ineffective, and the reduced rate of Captan would not be sufficient to give adequate protection by itself.

Rovral gives superior control of brown rot on cherries and peaches. Rovral has some postinfection activity and also reduces new spore production on established lesions. Because Rovral-resistant forms of the brown rot fungus can be easily selected in the laboratory, resistance could occur also in the orchard. Rovral-resistant forms of brown rot have been found in the field in New Zealand but not in recent surveys conducted in Ontario (1995–96).

Vangard was registered in North America in 1998. It has been registered for 4 yr in Europe for use on grapes for botrytis bunch rot and brown rot on stone fruit. Botrytis has already developed resistance to this product in Europe and the risk of resistance developing is expected to be similarly high for brown rot. Therefore take extreme caution not to overuse this new product. Limit use of Vangard to 2 applications/season, and never use in consecutive or back-to-back sprays.

Management of Resistance

Limit Rovral to only 1–2 applications/season to delay possible development of brown rot resistance to Rovral and cross-resistance to Botran and Ronilan. Apply Rovral when the crop is most susceptible to infection, such as at bloom and immediately preharvest, and use less effective materials when there is reduced risk of infection. Alternate Rovral with other fungicides to minimize resistance development.

Bravo, Sulfur and Captan are protective fungicides. Brown rot has not developed resistance to these products. Sulfur is not widely recommended. Sulfur can irritate the skin of those harvesting the fruit, and it kills beneficial mites, resulting in outbreaks of red mite. Captan is particularly valuable in programs designed to delay the development of fungicide resistance. Alternate Captan with other fungicides, so you can use resistance-prone fungicides, such as Rovral less frequently. A disadvantage of Captan is its phytotoxicity to a few sweet cherry cultivars (e.g., Schmidt), Stanley prune, and Japanese plums.

To date there are no documented cases of resistance to the new group of demethylation (DMI) fungicides, Topas, Funginex and Nova. In a few peach orchards in South Carolina where Topas has been used exclusively for 7–10 yr, preliminary observations suggest reduced sensitivity of brown rot isolates. This has not resulted in field control failures to date.

In order to manage resistance it is important to:

- minimize the number of applications/season/chemical group (see Table 10–5, *Chemical Families of Fungicides for Tender Fruit*)
- rotate between different chemical families (see Table 10–5)
- apply fungicides before an infection period, not as a clean-up spray after an infection has occurred.

TABLE 10–5. Chemical Families of Fungicides for Tender Fruit

Chemical Family	Brand Name Products	Risk of resistance mode of action	Restrict Number of Applications**/Season to Slow Development of Resistance
Benzimidazoles	Benlate, Senator	high, single site	high level of resistance; no longer recommended (if no resistance 2 applications/season)
Phthalimide	Captan, Maestro	low, multiple site	number of maximum applications has not been set
Dicarboximides	Rovral, Ronilan	moderate, single site	1–2 applications/season
Demethylation Inhibitors (S.I.'s)	Nova, Topas, Funginex	moderate, multiple gene mediated	2–3 applications/season
Chlorophenyl	Botran	low, multiple site	number of maximum applications has not been set
Chloronitrile	Bravo	low, multiple site	number of maximum applications has not been set
Strobilurins*		high, single site and multistep	2 applications/season
Anilinopyrimidines	Vangard	high, single site	2 applications/season; do not use in consecutive or back to back sprays.
Inorganic	Sulfur	low, multiple site	number of maximum applications has not been set

* not registered on tender fruit

** restrictions based on label and/or scientific literature

TABLE 10–6. Effect and Activity of Fungicides on Stone Fruit Diseases*

								Registered for Use on:					
Brand Name	**Brown Rot Blossom Blight**	**Brown Rot Fruit Phase**	**Rhizopus Rot**	**Cherry Leaf Spot**	**Powdery Mildew**	**Black Knot**	**Peach Leaf Curl**	**Apricot**	**Sweet Cherry**	**Peaches Nectarines**	**Plum**	**Sour Cherry**
Bravo 500	+++	X	X	++++	0	++++	++++		✓	✓		✓
Captan/Maestro	+++	+++	+	+++	0	++	+++ [1]	✓	✓	✓	✓	✓
Copper 53W	X	X	x	+++	++	X	++			✓		✓
Ferbam 76 WDG	0	0	x	++	0	0	++++			✓		
Funginex 190 EC	+++	X	x	+++	+++	0	0		✓	✓	✓	✓
Nova 40 W	+++	X	0	+++	++++	0	X		✓	✓	✓	✓
Rovral	++++	++++	++++	++	?	0	X	✓	✓	✓	✓	✓
Sulfur 92 SP	++	+	0	+	++	+ to ++	X		✓	✓	✓	✓
Topas 250E	++++	++++	++++	+++	+++	++	X	✓	✓	✓	✓	✓
Vangard 75 DF	+++	+++	+++	?	0	0	X	✓		✓	✓	

X not recommended or does not apply

[1] Most effective as spring dormant application

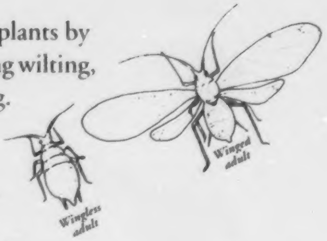
Registration Status Legend: ✓ registered on crop

* Use fungicides only for diseases listed on the product label.

0 not effective
+ slight
++ fair
+++ good
++++ very good
? unknown

Insects and Mites in Tender Fruit

Aphids



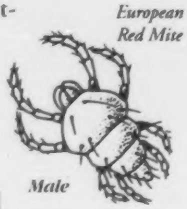
Aphids can weaken plants by removing sap, causing wilting, curling, or yellowing. Many spread diseases. They are often found in colonies, usually on the underside of leaves. They excrete a substance called "honeydew" that promotes development of black sooty mould on leaf and fruit tissues.

Aphids have complex life cycles. They may have winged or wingless forms. Winged aphids are associated with migration from one crop or host plant to another. Aphid populations can increase rapidly by asexual reproduction. Females can give birth to live young. For most of the year this means all individuals feeding on plants are females.

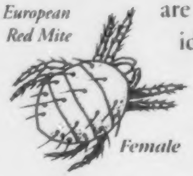
In Ontario many aphid species overwinter in the egg stage on primary hosts. In the spring the egg hatches and produces wingless offspring. These reproduce without mating, producing several generations of wingless females. When populations develop to high densities, or when hosts begin to die back or mature, winged forms are produced. These females migrate to secondary hosts — crops, weeds, ornamentals, etc. In the fall, when temperatures drop and daylength shortens, or when the plants slow their growth or die, winged forms (males and females) are once again produced. These fly back to primary hosts where they mate, lay eggs and die.

Peaches can tolerate infestations of up to 30% of their terminals or 20 colonies/tree. The threshold for control in nectarines is much lower at 10% terminal infestation (5–10 colonies/tree). Consider the presence or absence of predators before spraying. Most growers choose not to control aphids in bearing trees, except in extreme situations.

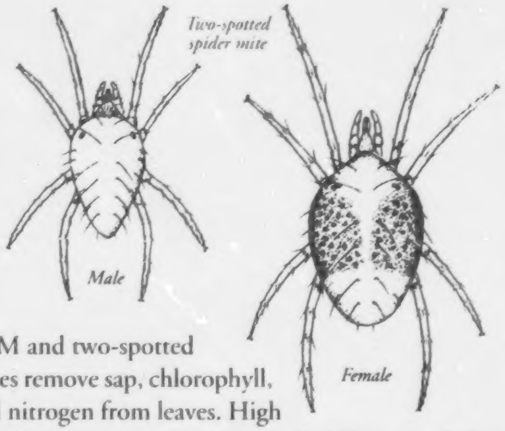
Mites



European red mite (ERM), two-spotted spider mite (TSSM), pear rust mite and pear leaf blister mite are potentially serious orchard pests.



Mites are small and are best counted and identified with a microscope. Nymphs have 3 pairs of legs while adults possess 4 pairs. Female ERM are bright red (males are a dull greenish-brown) with white spots and 6–8 hairs. Two-spotted spider mites are pale green to straw coloured, with 2 dark spots on their backs. High populations of two-spotted spider mites produce a characteristic webbing on the underside of leaves.



ERM and two-spotted mites remove sap, chlorophyll, and nitrogen from leaves. High populations cause a condition called "bronzing". Prolonged feeding, particularly if populations are heavy in early to mid-summer, leads to a reduction in shoot growth and fruit bud set the following year. Fruit colour, soluble solids, firmness, and size can also be affected.

ERM overwinter as eggs on the bark of trees. Two-spotted spider mites overwinter as adults on bark, on weeds, and on orchard debris. Development of mites is correlated to temperature. From egg to adult takes 7 days at 27°C, and 40 days at 13°C. There are several generations per year.

Mite counts are made by examining field-collected leaves under a microscope or with a 16X hand lens.

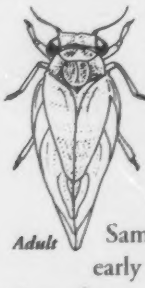
Include the total number of eggs, nymphs, and adults in the count. Loring and Babygold are useful indicator cultivars. Miticides can be effective against mite eggs, nymphs or both. Rotate different products to avoid the development of resistance. Applying Superior Oil to control overwintering ERM eggs is an important first step in mite management on sour cherries, peaches, and pears. The spray is especially important in blocks where pyrethroids are used for control of other orchard pests. Critical timing for summer applications, when thresholds are reached, is in early July.

TABLE 10–7. Thresholds for ERM and TSSM on Peaches

Stage of Crop Development	Threshold (in absence of predators)	Comments
Petal fall to 21 days after calyx	5–7 active mites/leaf	Foliage still young and expanding
June to mid-July	7–10 active mites/leaf	Control earlier if bronzing appears in the outer leaf canopy before this threshold is reached
Early July	10–15 active mites/leaf	Abide by pre-harvest intervals
Postharvest	50 mites/leaf	
Non-bearing	30 mites/leaf	

For more information, see OMAFRA factsheets *Mite Pest and Their Predators in Ontario Orchards*, Order No. 95-057 and *Beneficial Insects and Mites in Ontario Orchards*, Order No. 94-091.

Pear Psylla



Pear psylla adults overwinter in cracks of tree bark or under debris. Adults become active when temperatures reach 10°C. Mating and egg laying occur prior to bud break. There are 2–3 generations per year in Ontario.

Samples of fruit spurs in early March provide an indication of potential pest pressure. From mid-April through to harvest examine spurs, new terminals and water sprouts weekly for eggs, nymphs and adults. Tapping trays are useful for monitoring adults. A minimum of 25 fruit spurs and terminals (1/tree) per orchard provides a good sample of the stages present. Table 10–8, *Thresholds for Pear Psylla* provides thresholds for control. See OMAFRA factsheet *Pear Psylla in Ontario Pear Orchards*, Order No. 90-101 for more information on monitoring.

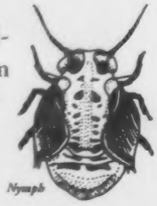
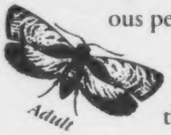


TABLE 10–8. Thresholds for Pear Psylla

Stage of Crop Development	Decision/Threshold
Delayed dormant	Previous history, adults present, egg laying started
White bud stage	10 eggs or more/spur with hatching started
Immediately at petal fall	10 actives/spur & majority of eggs hatched
Emergency summer spray #1	5–10 actives/sucker
Emergency summer spray #2	20 actives/sucker with low predator population; stickiness and fruit loss imminent

Oriental Fruit Moth



The Oriental fruit moth is one of the most serious pests of stone fruit in Ontario. A successful resistance management strategy exists for the control of this pest in peaches and nectarines.

The adult OFM is a small, dark grey moth (8–10 mm long), with wavy, light grey bands. Mature larvae have a brown head capsule, 3 pairs of legs, and a distinct pink body.

OFM larvae attack new terminals and fruit. Infested shoots wilt, developing a condition called "flagging" that is easily detected in the field. First generation larvae typically attack developing shoots. Subsequent generations (2nd–4th) attack fruitlets or ripe fruit. Fruit infested early in the season usually drop. Fruit injury can be conspicuous, with frass or gum exuding from the point of entry, or concealed, with entry occurring beside the stem. The latter is most common close to harvest. Pears can be attacked by the 2nd generation of OFM (early July). They are particularly vulnerable as fruit begins to ripen.

The OFM overwinters as a mature larva in tree bark and orchard debris. Other sources of infestation include fruit baskets and packing barns. There are 3–4 generations/yr in Ontario.

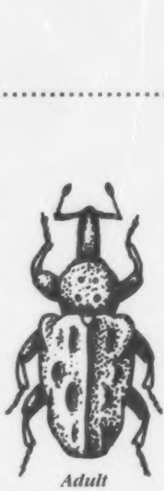
Emergence, flight and peak activity of OFM moths are monitored using pheromone traps. Spray at egg hatch, usually 3–6 days after peak flight is indicated from regional trap catches. The damage potential is too high to set a threshold based on trap catch. Examine shoots and fruit 7–10 days after a spray application to evaluate control.

In Nov. 2001, a product for mating disruption of OFM was registered in Ontario. Isomate M100 was granted temporary registration on stone fruit, apple and pear. The product is a pheromone, formulated in twist ties. Other products, including sprayable pheromone formulations, may soon be available. Mating disruption technology is used in grapes (see *Mating Disruption Technology (MD) for Grape Berry Moth* on page 140*)* and research shows it is extremely effective in controlling OFM in peaches.

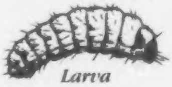
Mating disruption is pest-specific, and has low-toxicity to workers and beneficial organisms. Using this technology requires specific knowledge and management practices. You must monitor extensively throughout the season for OFM and secondary pests. Recommendations for mating disruption were not available when this document was printed. For more information on mating disruption, call the OMAFRA Agricultural Information Contact Centre, 1-877-424-1300 or visit the OMAFRA Web site.

Plum Curculio

Plum curculio (PC) creates a characteristic crescent-shaped egg-laying scar on the surface of fruit. PC larvae feed inside the fruit and are sometimes confused with OFM. They do not leave frass that is typically found in the entry wound of OFM larvae. Like OFM, PC have a 'clean exit hole'. Trained IPM scouts can tell the difference between PC and OFM damage and the difference between new and old egg laying scars.



Adult



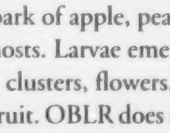
Larva

Plum curculio adults overwinter in wooded areas adjacent to orchards. They become active in the spring after a warm period and rain. Adults emerge over a 3–6 week period beginning just after bloom. Egg laying and fruit injuries begin within 2 weeks of emergence.

Apricots, cherries and plums located along borders of an orchard are good indicator plants for PC activity. Observe fruit along the outside 2–3 rows of the orchard next to wild hosts. Apply controls when new injury is found. Monitor 5–7 days following insecticide application to determine the need for reapplication. The best way to limit PC damage is to set up a rigorous monitoring program in areas with historic damage. When conditions are right in the spring, check developing fruit frequently and carefully, or enlist the services of a private crop consultant. PC is quite sporadic and often confined to border areas. Since these insects often enter orchards from rough or bush areas, a border spray of 2–4 rows may be sufficient control.

The window for control for PC is narrow. Problems can become worse each year if the pest is not adequately controlled. The 1st spray for Oriental fruit moth often (but not always) comes at a good time for control of PC. However, adult PC emerge over a long period and are actively laying eggs for more than a month. Ongoing monitoring for new damage is the key to successful control.

Obliquebanded Leafroller

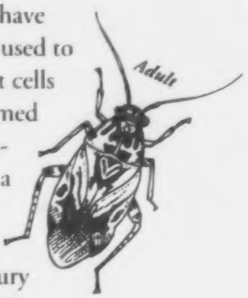


OBLR larvae can cause significant damage by feeding on the fruit during the shuck-fall period. They tie nearby leaves to the surface of fruit and feed on the fruit skin. OBLR larvae do not tunnel into the fruit, and prefer split-pit varieties.

OBLR overwinter as partially grown larvae in special cocoons under the bud scales or bark of apple, pear, cherry, and several other woody hosts. Larvae emerge in the spring and feed on the bud clusters, flowers, expanding leaves and developing fruit. OBLR does not successfully overwinter on peach, nectarine, or apricot because of cyanide content in the leaves. Early season damage in these crops is usually the result of overwintering larvae blown in from adjacent blocks of preferred hosts. Overwintering larvae complete their development and emerge as moths from mid-June through mid-July. The adult moths mate, and their progeny, 1st-generation larvae complete development from late-July through late-Aug. This generation feeds on both foliage and fruit. There are 2 generations/yr in Ontario.

Monitoring and thresholds: OBLR has not been a significant problem on peach and nectarine since a resistance management program for OFM was introduced. Pyrethroid use and timing for 2nd–4th generation OFM appears to control OBLR. However, OBLR can be a serious problem in apricot. Monitoring and controlling leafroller populations in surrounding crops such as sweet cherry, apple, and pear can reduce pest pressure. Sampling involves checking shoots and fruit spurs from tight cluster through to petal fall, and from 1st cover to harvest.

Tarnished Plant Bug



Tarnished plant bugs (TPB) have piercing sucking mouthparts used to sting fruit. Feeding kills plant cells and, as a result, fruit is deformed as it continues to grow. Damaged fruitlets may also exude a clear gummy substance. Pest injury varies between site and cultivar. Activity and injury depends on temperature (17°C –20°C). Humid, hot, windy, or dry weather can promote TPB migration from weedy alternate hosts or crops into orchard blocks.

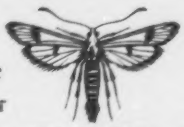
Adult TPB overwinter under leaf debris, bark, logs, and under broadleaf weed litter. They become active on warm days early in the spring and may attack developing buds and fruitlets. In late spring (early May and June), they migrate to herbaceous weeds, flowers, and vegetables, where they lay eggs into stems and stalks.

Use sweep nets to monitor TPB on weedy hosts. Monitor the development of nymphs through the later instars. The appearance of new summer adults indicates the timing of when potential fruit injury will begin. Monitor fruit for damage by sampling a minimum of 100 fruit/block. Border sprays are warranted when 2% of fruit, collected from the edge of the orchard, are damaged. Apply secondary block sprays when injury levels reach 2%–5% throughout the block.

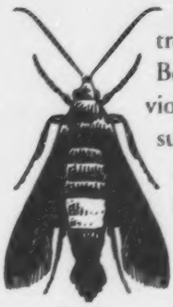
Cover crop management is important to prevent tarnished plant bugs from moving into trees at critical points in plant development. Use these management practices, together with insecticides, to minimize the size of TPB populations within the orchard and to provide an alternate food source for the summer generations of migrant plant bugs.

- Remove any large oak trees adjacent to peach blocks to avoid oak bug injury. White and red oaks are more important than the Burr type.
- Apply a contact herbicide in the herbicide strip areas (e.g., paraquat) to early season hosts of plant bug which are mainly mint, creeping charlie, and annual and perennial chickweed. In most years, apply herbicide by about Apr. 20th in southwestern Ontario and May 1st in the Niagara Peninsula.
- Apply a 2nd herbicide, such as a contact plus residual, to the herbicide strip area in the latter part of May to provide season-long control of weeds in your orchard.
- Where clean cultivation is practised, begin as early as possible and continue up to about May 15th in southwestern Ontario and June 1st in the Niagara Peninsula. Early cultivation reduces the number of resident plant bugs. Stop cultivation in June to encourage weeds such as pigweed and lamb's-quarters to establish. These provide an alternate food source for 1st generation plant bugs, discouraging feeding on peach fruit.
- Where sod culture is adopted, mow frequently, e.g. every 2 weeks. Use fertilizer and herbicides as needed to encourage weed-free sod. Creeping red fescue or other grasses are the preferred species for sod. Avoid clover.
- If you use cover crops in cultivated peach orchards to lower nitrogen levels and check tree growth, delay preparing and sowing of the cover crop until July 10th when the major danger of extensive plant bug injury is over.

Peachtree Borers



Male Peachtree Borer



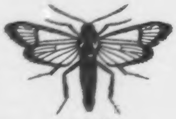
Female Peachtree Borer

Peachtree borer (PTB) larvae damage stone fruit trees by boring into trunks and branches, feeding on the growing tissue (cambium) and inner bark. The PTB confines its activities to the trunk area; feeding can completely girdle and kill young trees. Larvae of the Lesser Peachtree Borer (LPTB) are associated with previously damaged or diseased plant tissues (trunks, scaffold limbs, branches) including cankers, pruning wounds, and winter- and insect-injured areas.

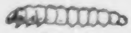
Both species overwinter as larvae. The PTB completes its development in the summer, with adult moths emerging from July through Sept. Emergence pattern of the LPTB is prolonged and less synchronous, and occurs from late May through Sept. (peaks occur from June through July).

Pheromone traps are used to monitor the emergence of male moths throughout the season. In areas with high peachtree borer pressure (southwestern Ontario), controls are timed to coincide with peak moth activity. Monitor trees for the presence and abundance of peachtree borers. Examine trees for the presence of sawdust-like frass and exuded gum. The pupal cases of emerged moths can often be found near the surface of damaged tissues.

Lesser Peachtree Borer



Adult



Larva

Lesser peachtree borer and peachtree borer can be serious problems in apricot blocks. Redirect a nozzle when spraying insecticides for plum curculio and preharvest cover sprays. This provides spray coverage of the trunks and lower scaffolds.

Visit the tender fruit page on the OMAFRA Web site at
www.gov.on.ca/OMAFRA/english/crops/hort/tenderfruit.html

Apricot Calendar

Read the label and follow all safety precautions.
Rates are based on tree size of 4.5–5.5 m high. Refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases & Insects	Materials	Amount/ 1,000 L	Amount/ha	Comments
Dormant (in late March or early April before buds swell)				
European red mite	• Superior Oil	20 L	60 L	Rate/1,000 L is based on 11.4–13.6 L of spray/mature tree.
Prebloom (when blossom buds show pink)				
Brown rot Blossom blight	• [5]Topas 250E	165 ml	500 ml	Apricots are extremely susceptible to brown rot at blossom time and just before picking. **Do not apply Rovral or Vangard more than 2 times for each product/season.** Alternate between fungicides and do not use the same product in consecutive sprays. See *Management of Resistance* on page 152.
	• Rovral	0.50 kg	1.50 kg	
	• Captan 80 WDG	1.50 kg	4.50 kg	
	or [4]Maestro 80 DF	1.50 kg	4.50 kg	
	• [4]Vangard 75 WG	123 g	370 g	
Do not apply insecticides while apricot trees are in bloom. See *Bee Poisoning* on page 58.				
Shuck Split (when about 50% of shucks have split)				
Brown rot	• [5]Topas 250 EC	165 mL	500 mL	Apricots are extremely susceptible to brown rot.
	• Rovral	0.50 kg	1.50 kg	
	• Captan 80 WDG	1.50 kg	4.50 kg	
	or [4]Maestro 80 DF	1.50 kg	4.50 kg	
	• [4]Vangard 75 WG	245 g	740 g	
Plum curculio	• [4]Guthion Solupak	775 g	2.30 kg	
	or [4]Sniper	775 g	2.30 kg	
	• [6]Parathion 15 WP	1.75 kg	5.25 kg	
	• Sevin XLR Plus	2.10 L	6.25 L	
Shuck Fall (10–12 days after last spray)				
Brown rot Plum curculio	Use same materials as for **Shuck Split**			For peachtree borer, refer to treatment as for peaches. See page 168.
First Cover (10–12 days after Shuck Fall)				
Brown rot	Use one of the fungicides listed under **Shuck Split**.			
Plum curculio	Use one of the insecticides listed for plum curculio at **Shuck Split**.			
Special Sprays				
European red mite	• Kelthane 50 W	1.10 kg	3.25 kg	European red mite is a sporadic pest and is rarely a problem in apricot orchards. Apply when mites build up to 10 active stages/leaf.
Leafrollers	• Dipel 2X DF		1.12 kg	
Prepick to Harvest				
Brown rot	Use one of the fungicides listed under **Shuck Split**.			Apricots are extremely susceptible to brown rot just before picking. Additional sprays may be required during harvest if conditions are wet.

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[1] *Minimum period for re-entry is 4 hrs.* [2] *Minimum period for re-entry is 12 hrs.* [3] *Minimum period for re-entry is 24 hrs.* [4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Use this table as a guide, but refer to product label for specific information.

TABLE 10–9. Days to Harvest Intervals for Products Used on Apricots

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
Captan 80 WDG	2	Maestro 80 DF	2	Sniper	21
Dipel 2X DF	1	Parathion 15 WP	14	Superior 70 Oil	PB
Guthion Solupak	21	Rovral	1	Topas 250 EC	3
Kelthane 50 W	14	Sevin XLR Plus	5	Vangard 75 WG	2

PB: prebloom only

Disease Control for Apricots

Verticillium Wilt

Do not plant apricots following tomatoes, strawberries, potatoes, eggplants or peppers. Also do not interplant with these crops.

Bacterial Spot

There is no satisfactory chemical control for bacterial spot during the cropping season. The use of fixed copper sprays when trees are dormant can lower overwintering bacterial levels, and delay the progress of disease on leaves and fruit.

See *Stone Fruit Diseases* on page 151.
See *Insects and Mites in Tender Fruit* on page 154.

Sour Cherry Calendar

Read the label and follow all safety precautions.
Rates are based on tree size of 4.5–5.5 m high. Refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
Prebloom			
European red mite	• Superior 70 Oil	60 L	Only needed in sour cherry orchards with a heavy mite population. Spray as buds are breaking. Apply oil in 3,000 L/ha (dilute rate).
Bloom			
	Do not apply insecticides while cherry trees are in bloom. See *Bee Poisoning* on page 58.		
Brown rot (stem rot and blossom blight stages)	• [5]Topas 250 E • Nova 40 W • Rovral • [4]Bravo 500 • Captan 80 WDG or [4]Maestro 80 DF • Funginex 190 EC • Kumulus DF	500 mL 340 g 1.50 kg 7.00 L 4.50 kg 4.50 kg 2.50 L 22.50 kg	Spray just before blooms open if weather conditions are expected to be wet and warm (above 16°C) during bloom. Sour cherries are less susceptible to brown rot than sweet cherries. One application during bloom should be sufficient, unless frequent wet periods occur and brown rot pressure is high. Do not use Captan or Maestro within 14 days of an oil application. Nova is most effective when applied as a protectant fungicide prior to an infection or wetting period. Nova and Topas are absorbed by flower parts, making this material more rainfast than other protectant fungicides. Do not use Rovral more than 2 times/season and never in consecutive sprays. See *Brown Rot Control* on page 151. Rovral is only necessary under high disease pressure. Do not apply Bravo 500 within 10 days of an oil application as it causes burning to flower and leaf tissue.
Petal Fall			
Leaf spot	• [4]Bravo 500 • Captan 80 WDG or [4]Maestro 80 DF • Nova 40 W • Ferbam 76 WDG • Equal 65 WP	7.00 L 4.50 kg 4.50 kg 340 g 6.00 kg 2.25 kg	Spray only if rain is forecast between **Bloom** and **Shuck** sprays. Make no more than 4 applications of Nova/season. Apply 1 application of Bravo 500 to control early season leaf spot. After **Shuck Split** rotate with other products as a resistance management strategy.
Black knot	• [4]Bravo 500	7.00 L	This spray is only needed on sour cherry orchards with a history of this disease. Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. Do not apply Bravo 500 after **Shuck Split** to avoid fruit injury.
Shuck			
Plum curculio	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Zolone Flo • Imidan 50 WP	2.30 kg 2.30 kg 2.30 kg 2.00 L 3.75 kg	Spray when most shucks are off and plum curculio activity is observed. Zolone also helps control aphids. Make no more than 3 applications of Zolone Flo/season.
Brown rot	• [5]Topas 250 E • [4]Bravo 500 • Captan 80 WDG • or [4]Maestro 80 DF • Rovral	500 mL 7.00 L 4.50 kg 4.50 kg 1.50 kg	Do not apply Rovral more than 1 or 2 times/season, and never in consecutive sprays. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.
Leaf spot	Use one of the fungicides recommended at **Petal Fall** with the exception of Ferbam.		

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
European red mite	• Kelthane 50 W	3.25 kg	Thorough coverage is necessary for good mite control. Only needed in heavily infested sour cherry orchards.
Black knot	• [4]Bravo 500	7.00 L	
First Cover (12 days after Shuck)			
Plum curculio	Use one of the insecticides listed under **Shuck.**		Monitor 7 days after shuck fall insecticide for new plum curculio damage. If crescent-shape cuts on fruit are found, then apply an insecticide. Zolone helps control aphids.
Leaf spot	Use one of the fungicides listed under **Petal Fall** with the exception of Ferbam.		
Second Cover (12 days after First Cover)			
Cherry fruit fly Plum curculio	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Diazinon 50 W or DZN 600EW • Zolone Flo • Imidan 50 WP	2.30 kg 2.30 kg 2.30 kg 3.00 kg 2.50 L 2.00 L 3.75 kg	On early varieties, check interval from last spray to harvest date. Spray when early varieties are beginning to colour. Diazinon and DZN 600 EW are not labelled for and do not adequately control plum curculio. Zolone provides 12–14 days protection against cherry fruit fly while Diazinon provides 10 days. Make no more than 3 applications of Zolone Flo/season.
Leaf spot	Use one of the fungicides recommended at **Petal Fall** with the exception of Ferbam.		
Powdery mildew	• Nova 40 W • Benlate T-N-G • Kumulus DF	340 g 1.75 kg 12.00 kg	Make no more than 4 applications of Nova/season. Kumulus at this rate suppresses powdery mildew. Higher rates may cause injury.
Third Cover			
Cherry fruit fly	• Sevin XLR Plus • Imidan 50 WP • Zolone Flo • Diazinon 50 W or DZN 600 EW	6.25 L 3.75 kg 2.00 L 3.00 kg 2.50 L	Spray sour cherries about the time Montmorency is turning pink. Sevin provides 5–7 days protection. Make no more than 3 applications of Zolone Flo/season.
Leaf spot	Add one of the fungicides listed under **Petal Fall** with the exception of Ferbam.		
Preharvest			
Brown rot	Add one of the fungicides listed under **Petal Fall.**		
Postharvest			
Leaf spot	• [4]Bravo 500 • Captan 80 WDG or [4]Maestro 80 DF • Nova 40 W • Ferbam 76 WDG • Equal 65 WP	7.00 L 4.50 kg 4.50 kg 340 g 6.00 kg 2.25 kg	Necessary where leaf spot is a problem. Make no more than 4 applications of Nova/season.
Powdery mildew	• Benlate T-N-G	1.75 kg	
European red mite	• Kelthane 50 W	3.25 kg	If mites can easily be found on the leaves at this time, add a miticide with your fungicide application.
Special Sprays			
Aphids	• Diazinon 50 W or DZN 600 EW • Thiodan 50 WP or Endosulfan 50W • Zolone Flo	3.00 kg 2.50 L 3.25 kg 3.25 kg 2.00 L	These may be added to any of the sprays after bloom. Thorough coverage and a calm, warm day are necessary for good aphid control. Make no more than 3 applications of Zolone Flo/season.
Peachtree borer	• Thiodan 50 WP or Thionex 50 WP or Endosulfan 50W • Sevin XLR Plus	1.5 kg/1,000L 1.5 kg/1,000L 1.5 kg/1,000L 6.25 L	Apply 3 sprays 3 weeks apart. Apply 1st spray 10 days after 1st adult catch in pheromone traps. Direct these sprays with a hand gun to cover the trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the 2nd spray, and do not apply if the fruit is to be harvested during this period.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Use this table as a guide, but refer to product label for specific information.

TABLE 10–10. Days to Harvest Intervals for Products Used on Sour Cherry

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
APM 50 W	15	Ferbam 70 WDG	4	Nova 40 W	1
Benlate T-N-G	1	Funginex 190 EC	C	Rovral	1
Bravo 500	40	Guthion Solupak	15	Sevin XLR Plus	2
Captan 80 WDG	5-sour 2-sweet	Imidan 50 WP	7	Sniper	15
Diazinon 50 W	10	Kelthane 50 W	7	Thiodan 50 WP	15
DZN 600EW	10				
Endosulfan 50 W	15	Kumulus DF	1	Thionex 50 WP	15
Equal 65 WP	7	Maestro 80 DF	5-sour 2-sweet	Topas 250 EC	3
				Zolone Flo	14

C: Do not use later than recommended in calendar.

Disease Control for Sour Cherries

TABLE 10–11. Cherry Leaf Spot

Approximate Number of Hours of Wetting Required for Conidial Infection by the Leaf Spot Fungus at Different Air Temperatures [1]

Average Temperature (°C)	WETTING PERIOD [hr] Light Infection [2]	Moderate Infection [2]	Heavy Infection[2]
27	25	39	—
25	14	24	36
23	8	17	26
21	6	13	21
17-20	5	12	19
16	6	13	20
13	10	17	24
10	19	27	35
8	26	36	48

[1] Adapted from Eisensmith and Jones, 1981. Plant Disease 65: 955-958 and Phytopathology 71: 728-732.

[2] The infection period starts when rain begins.

Growth Regulators

Ethephon to Promote Fruit Loosening of Sour Cherries

Ethephon (Ethrel) can be used in sour cherry orchards to promote fruit loosening, uniform maturity, and to facilitate mechanical harvesting.

The effectiveness of Ethrel treatment depends on several factors, particularly ambient temperature and tree vigour. The response time of the tree to Ethrel application increases with higher temperatures and decreases at lower temperatures. For this reason, apply Ethrel only in the temperature range of 18°C–30°C. Remember that hot weather shortens the time needed for response.

Tree vigour also affects the effectiveness of Ethrel treatment. Trees with low vigour, or trees severely stressed by drought, disease or winter injury indicated by gumming on the trunk and scaffold limbs, should not receive Ethrel sprays. Treat only trees that are vigorous and in good health.

Apply ethephon at a rate of 200 ppm ethephon (1 L/1,000 L water), 7–10 days prior to anticipated harvest. This rate provides an adequate response to enhance fruit loosening to facilitate mechanical harvesting. Consult the product manufacturer for further information.

Cherry Yellows Virus and Use of Gibberellic Acid

To moderate early production, apply Gibberellic Acid (GA) at 15 ppm in the 4th year. This allows flowering in year 5 at a reasonable level rather than allowing heavy bloom and production that may significantly reduce growth in future years.

In mature Montmorency sour cherry trees that are infected with yellows virus, annual applications of GA can help maintain and extend high fruiting capacity and reduce occurrence of blind nodes by stimulating lateral shoots and spurs. Apply about 3 weeks after full bloom, from shuck fall to 2 weeks after shuck fall. Concentrations of 10–20 ppm are used, with 15 ppm most common. Use lower rates on more vigorous trees. For specific application instructions including temperature and humidity, consult the product label.

Sweet Cherry Calendar

Read the label and follow all safety precautions.
Rates are based on tree size of 4.5–5.5 m high. Refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
Bloom			
			Do not apply insecticides while cherry trees are in bloom. See *Bee Poisoning* on page 58.
Brown rot (stem rot and blossom blight stages)	• [5]Topas 250 E • Nova 40 W • Rovral • [4]Bravo 500 • Captan 80 WDG or [4]Maestro 80 DF • Funginex 190 EC	500 mL 340 g 1.75 kg 7.00 L 4.50 kg 4.50 kg 2.50 L	Blossom blight is favoured by wet, warm (above 16°C) weather, especially when large numbers of mummies are present in the trees. Apply 1st spray just before blossoms open, followed by 2 additional sprays during the bloom period if weather remains favourable for blight. Do not use Captan or Maestro within 14 days of an application of Superior Oil. Do not apply Rovral more than 2 times/season and never in consecutive sprays. See note on *Brown Rot Control* on page 151. Nova is most effective when applied as a protectant fungicide prior to an infection or wetting period. Nova and Topas are absorbed by the flower parts, making these materials more rainfast than other protectant fungicides. Do not apply Bravo 500 after shuck to avoid fruit injury.
Petal Fall			
Black cherry aphid	• Diazinon 50 W or DZN 600EW • Thiodan 50 WP or Endosulfan 50 W • Zolone Flo	3.00 kg 2.50 L 4.50 kg 4.50 kg 2.00 L	A temperature of at least 21°C, thorough coverage and a calm day are needed for effective aphid control. Usually 1–2 sprays are required. Make no more than 3 applications of Zolone Flo/season.
Shuck Fall			
Plum curculio	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper 50 W • Zolone Flo	2.75 kg 2.75 kg 2.75 kg 2.00 L	Spray when most of the shucks are off and plum curculio activity is observed, usually when temperatures are above 16°C. Zolone also helps control aphids. Make no more than 3 applications of Zolone Flo/season.
Brown rot	• [5]Topas 250 E • Rovral • Captan 80 WDG or [4]Maestro 80 DF	500 mL 1.75 kg 4.50 kg 4.50 kg	Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays. Do not apply Rovral more than 2 times/season and never in consecutive sprays.
First Cover **(12 days after Shuck Fall)**			
Plum curculio	Use one of the insecticides listed under **Shuck Fall.**		Zolone helps control aphids but is only fair against plum curculio. Monitor 7 days after **Shuck Fall** insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.
Brown rot	Use one of the fungicides listed under **Shuck Fall.**		
Second Cover **(12 days after First Cover)**			
Cherry fruit fly Plum curculio	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Diazinon 50 W or DZN 600EW • Zolone Flo	2.30 kg 2.30 kg 2.30 kg 3.00 kg 2.50 L 2.00 L	On early varieties, check interval from last spray to harvest date. Spray when early varieties are beginning to colour. Diazinon and DZN 600EW do not adequately control curculio. Zolone provides 12–14 days protection against cherry fruit fly while Diazinon and DZN 600EW provide 10 days. Make no more than 3 applications of Zolone Flo/season.
Brown rot	• [5]Topas 250 EC • Rovral • Captan 80 WDG or [4]Maestro 80 DF	500 mL 1.75 kg 4.50 kg 4.50 kg	Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays. Do not apply Rovral more than 2 times/season and never in consecutive sprays. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Third Cover			
Cherry fruit fly	• Sevin XLR Plus • Zolone Flo • Diazinon 50 W or DZN 600EW	6.25 L 2.75 L 3.00 kg 2.50 L	Sevin XLR Plus provides 5–7 days protection. Make no more than 3 applications of Zolone Flo/season. Check interval to harvest before spraying early maturing cherries.
Brown rot	Add one of the fungicides listed under **Second Cover**.		
Prepick			
Brown rot	• Rovral • Captan 80 WDG or [4]Maestro 80 DF	1.75 kg 4.50 kg 4.50 kg	Consult product labels for days-to-harvest intervals. Do not apply Rovral more than 2 times/season and never in consecutive sprays. Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays.
Postharvest			
Leaf spot	• Equal 65 WP • Captan 80 WDG or [4]Maestro 80 DF • Ferbam 76 WDG	2.25 kg 4.50 kg 4.50 kg 6.00 kg	Only necessary where leaf spot is a problem or where sweet cherries are beside sour cherries. Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays.

Use this table as a guide, but refer to product label for specific information.

TABLE 10–12. Days to Harvest Intervals for Products Used on Sweet Cherry

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
APM 50 W	15	Equal	7	Rovral	1
Bravo 500	40	Ferbam	4	Sevin XLR Plus	2
Captan 80 WDG	5-sour 2-sweet	Funginex 190 EC	C	Sniper	15
Diazinon 50 W	10	Guthion Solupak	15	Thiodan 50 WP	15
DZN 600EW	10				
Endosulfan 50 W	15	Maestro 80 DF	5-sour 2-sweet	Topas 250 EC	3
		Nova 40 W	1	Zolone Flo	14

C: Do not use later than recommended in calendar.

See *Stone Fruit Diseases* on page 151.
See *Insects and Mites in Tender Fruit* on page 154.

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[1] *Minimum period for re-entry is 4 hrs.* [2] *Minimum period for re-entry is 12 hrs.* [3] *Minimum period for re-entry is 24 hrs.*
[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Peach & Nectarine Calendar

Read the label and follow all safety precautions.
Rates are based on tree size of 4.5–5.5 m high. Refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant (In March or early April before buds swell)			
Leaf curl	• Ferbam 76 WDG • [4]Bravo 500	6.75kg 7.00 L	Delay may result in poor control of leaf curl. Do not apply Bravo 500 within 10 days of an oil application, as it will burn flower and leaf tissue.
(Leaf curl spray is not needed in spring if a spray was applied last fall)			
San Jose scale	• Superior 70 Oil	60 L	Apply oil routinely every 3rd yr. If scale is a serious or continuing problem, apply oil for at least 2 consecutive yr. Poor control of leaf curl may result if instructions for mixing products are not followed. Add Ferbam to water in a partially-filled tank before adding oil. With agitator running, sift Ferbam slowly into water or, preferably, slurry in with water in a pail and then add to tank. Add oil last, as remainder of water is being added. To keep mixture uniform, do not stop agitation until contents of tank are sprayed out. If oil is noticed floating on top of water, remix by turning a spray gun into tank. Injury may result to last few trees at the end of tank if emulsion breaks.
Prebloom (Half-inch Green to First Pink)			
European red mite	• Superior 70 Oil	60 L	Preferred time to use oil for red mite control if overwintering populations are high. Red mite populations are more likely to be high if pyrethroid sprays were used the previous year for Oriental fruit moth and tarnished plant bug control.
Pink through Bloom			
Blossom blight stage of brown rot	• [5]Topas 250 E • Nova 40 W • [4]Bravo 500 • Captan 80 WDG or [4]Maestro 80 DF • Funginex 190 EC • Rovral • [4]Vangard 75 WG • Sulphur 92 WP	500 mL 340 g 7.00 L 4.50 kg 4.50 kg 2.50 L 1.50 kg 370 g 19.50 kg	Spray when 1st blossoms are opening (late pink). Repeat every 4–5 days if weather is wet. To avoid resistance, alternate between fungicides and do not use Rovral, Funginex or Vangard more than 2 applications/season and never in consecutive sprays. For more information on resistance management of products such as Rovral or Vangard see *Brown Rot Control* on page 151. Using sulphur may encourage mite build-up. Do not apply Bravo, Captan or Maestro within 10 days of an oil application, because this causes burning of flower and leaf tissue.
Petal Fall and Shuck Spray			
Mealybug	• [6]Parathion 15 W	5.25 kg	Check for mealybug when shucks start to split and if necessary apply spray at 50% shuck split and repeat in 10–12 days. Thorough coverage is essential to control mealybug.
Green peach aphid	• [3]Pirimor 50DF	560 g	Restrict the application to no later than **Shuck Fall**. Observe the days-to-harvest interval.
First Generation Oriental Fruit Moth Spray Shuck Split			
Oriental fruit moth	• [3] Lorsban 50 W • [4] Guthion Solupak or [4] APM 50 W or [4] Sniper • Imidan 50 WP • [6] Parathion 15 W	3.50 kg 2.30 kg 2.30 kg 2.30 kg 3.75 kg 5.25 kg	Widespread resistance has developed in most areas of Ontario to the organophosphate insecticides Guthion/APM and parathion, and the carbamates such as Sevin. Resistance to pyrethroids is also developing at low levels. Use Lorsban for the control of generation #1 and pyrethroids for generations 2–4 to provide rotation of chemical families to avoid rapid selection of resistance to the pyrethroid insecticides. Do not use pyrethroids for 1st generation control of OFM.

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[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Plum curculio	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper	2.30 kg 2.30 kg 2.30 kg	Plum curculio is a sporadic pest of peaches and nectarines. Scout edges of orchards near woodlots and waste areas in spring. Check small fruit for crescent-shaped egg laying scars. If damage is present, it will often occur only on the border of the orchard, and a border spray of 4–6 rows may provide sufficient control. Check developing fruit for new damage 7–10 days later.
Brown rot	• [5] Topas 250 E • Rovral • Captan 80 WDG or [4]Maestro 80 DF • Sulphur 92 WP • [4] Vangard 75 WG	500 mL 1.50 kg 4.50 kg 4.50 kg 19.50 kg 740 g	Under rainy conditions and high levels of blossom blight apply Rovral. Alternate between fungicides and do not use Rovral or Vangard more than 2 applications/season and never in consecutive sprays. For more information on resistance management of products such as Rovral or Vangard see *Brown Rot Control* on page 151. Apply another fungicide in 7 days if wet weather persists.
European red mite	• Apollo SC • Kelthane 50 W	300 mL 3.25 kg	If oil was applied in the spring, a miticide is likely not necessary at this time. Apollo is most effective on eggs and newly hatched nymphs. Apply when leaf tissue is present, mites are mostly in the 1st summer generation egg stage, and before there are 3 active mites/leaf. Use sufficient water volumes to obtain good coverage, but not less than 475 L/ha. Apply up to 14 days after petal fall. Make no more than 1 application/season to prevent rapid development of mite resistance. Kelthane is most effective on mite nymphs. Check leaves and apply if 5–7 active mites per leaf are present. Kelthane is a slow-acting material, so wait 7–10 days after use to evaluate results. Repeated use of Kelthane has led to red mite resistance.
Lesser peachtree borer Peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4 EC • Sevin XLR Plus	1.50 kg/1,000L 1.50 kg/1,000L 1.75 L/1,000L 6.25 L	In areas with high borer populations such as Essex and Kent counties, follow this spray regime. Make 3 applications beginning 5–10 days after the 1st Oriental fruit moth spray, and continuing at 3-week intervals. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly. Check the days-to-harvest interval. Do not apply 2nd Thiodan spray to varieties in the Harrow Diamond and Garnet Beauty season. On these varieties use Sevin XLR Plus. Do not use 3rd Thiodan spray on varieties in the Sunhaven, Redhaven, Veecling and Vivid season. On these varieties use Sevin XLR Plus.
Special Sprays Early Green Fruit Stage to Pit Hardening			
Tarnished plant bug	• Cymbush 250 EC • [3]Matador 120 EC • Thiodan 50 WP or Endosulfan 50 W • [4]Guthion Solupak or [4]APM 50 W or [4]Sniper	280 mL 104 mL 4.50 kg 4.50 kg 2.30 kg 2.30 kg 2.30 kg	General timing is mid-June. Where plant bug pressure is high, sprays may have to be repeated in 5–7 days.
Second Generation Oriental Fruit Moth Spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Pounce • [3]Matador 120 EC • [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Imidan 50 WP • [6]Parathion 15W	280 mL 200 mL 275 mL 104 mL 2.30 kg 2.30 kg 2.30 kg 3.75 kg 5.25 kg	Spray all varieties. This generation may require 2 insecticide sprays applied about 14 days apart. Widespread resistance has developed in most areas of Ontario to the organophosphate insecticides, Guthion/APM and parathion, and the carbamates including Sevin. Resistance to pyrethroids is also developing at low levels. Where resistance is not a problem, use Imidan or Guthion.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Brown rot (early varieties only) Harrow Diamond through Sunhaven	• [5]Topas 250 E • Captan 80 WDG or [4]Maestro 80 DF • Rovral • Sulphur 92 WP • [4]Vangard 75 WG	500 mL 4.50 kg 4.50 kg 1.50 kg 19.5 kg 740 g	Use of sulphur may induce mite problems. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. For more information on resistance management of products such as Rovral or Vangard see *Brown Rot Control* on page 151.
Special Sprays			
European red mite Two-spotted spider mite	• [3]Pyramite • Kelthane 50 W • Carzol SP	300 g 3.25 kg 1.10 kg	This spray usually can be applied around the **Second Oriental Fruit Moth Spray** (early July). On cultivars Harbrite and later, examine for mites again 3 weeks before harvest. Take action if the threshold of 5–10 active mites/leaf (European red mite plus two-spotted spider mite) is reached in July. Monitor carefully because populations can build rapidly. Check product labels for preharvest intervals. Pyramite is the preferred material at this timing. Pyramite is most effective when applied to mite nymphs. Use 600 grams/ha if outbreaks of two-spotted spider mites occur. Miticides are best used alone. Use a minimum water volume of 1,000 L/ha for effective control. Pyramite has a 14 days-to-harvest interval. Make no more than 1 application/season. If 2 miticides are needed during July and Aug. on late maturing cultivars, alternate between materials. Observe days-to-harvest intervals.
Third Generation Oriental Fruit Moth Spray (Late Varieties)			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Pounce • Imidan 50 WP	280 mL 200 mL 275 mL 3.75 kg	Usually for all varieties from Harbrite-Vivid season and later (about Aug. 4).
Brown rot	• [5]Topas 250 E • Captan 80 WDG or [4]Maestro 80 DF • Rovral • Sulphur 92 WP • [4]Vangard 75 WG	500 mL 4.50 kg 4.50 kg 1.50 kg 19.5 kg 740 g	To be included in all varieties. Use of sulphur may induce mite problems. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. For more information on resistance management of products such as Rovral or Vangard see *Brown Rot Control* on page 151.
Prepick Spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Pounce • Imidan 50 WP	280 mL 200 mL 275 mL 3.75 kg	Spray each variety 7–10 days before 1st harvest when first colour shows. See comments on organophosphate resistance under **First Oriental Fruit Moth Spray**.
Brown rot	• [5]Topas 250E • Captan 80 WDG or [4]Maestro 80 DF • Rovral • Sulphur 92 WP • [4]Vangard 75 WG	500 mL 4.50 kg 4.50 kg 1.50 kg 19.5 kg 740 g	Apply with OFM sprays 7–10 days before harvest. Use Rovral if brown rot pressure is high (adjacent blocks with split pits) and weather is humid and/or wet. Use of sulphur may induce mite problems. For more information on resistance management of products such as Rovral or Vangard see *Brown Rot Control* on page 151.
Rhizopus rot	• Botran 75 W	5.25 kg	
Special Spray			
Brown rot	• Rovral • Sulphur 92 WP • [4]Vangard 75 WG	1.50 kg 19.5 kg 740 g	This spray is only necessary under rainy and humid conditions just prior to harvest (within 3 days of picking). This is the preferred time to use Rovral. Use of sulphur may induce mite problems. For more information on resistance management of products such as Rovral or Vangard see *Brown Rot Control* on page 151.
Fall Spray (Preferred time to spray for leaf curl)			
Leaf curl	• Ferbam 76 WDG • [4] Bravo 500	6.75 kg 7.00 L	Apply any time after leaves are off in fall or winter when temperature in shade is above freezing and conditions favour rapid drying.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Use this table as a guide, but refer to product label for specific information.

TABLE 10–13. Days to Harvest Intervals for Products Used on Peach

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
APM 50 W Instapak	21	Funginex 190 EC	C	Pounce	7
Apollo SC	PF	Guthion Solupak	21	Pirimor 50 DF	60
Botran 75 W	10	Imidan 50 WP	1	Pyramite	14
Bravo 500	60	Kelthane 50 W	14	Rovral	1
Captan 80 WDG	2	Lorsban 50 W	21	Sevin XLR Plus	1
Carzol SP	21	Maestro 80DF	2	Sniper	21
Cymbush 250 EC	7	Matador 120 EC	7	Superior 70 Oil	PB
Decis 5 EC	1	Microscopic Sulphur	1	Thiodan 4 EC	15
Endosulfan 50 W	15	Nova 40 W	1	Thiodan 50 WP	15
Ferbam 76 WDG	21	Parathion 15 W	14	Topas 250 EC	3
				Vangard 75 WG	2

PB: pre-bloom only
PF: within 14 days of petal fall
C: Do not use later than recommended in calendar.

Guidelines for Protecting Young Non-Bearing Peach Plantings

The following is designed to offer limited protection when needed for newly planted trees. Do not use for protection of bearing orchards. Rates are based 1,000 L/ha for dilute spraying.

Diseases and Insects	Materials	Amount/1,000 L	Comments
Preplant			
Nematodes	Peaches are very susceptible to nematodes. See *Nematode Control* on page 46		
Lesser peachtree borer Peachtree borer	• Thiodan 4 EC	1.25 L/1,000 L	If trees were not treated at the nursery, dip the roots and crown. The dip provides control for peachtree borer in the 1st yr. Use rubber gloves to avoid exposing skin to insecticide. Dispose of excess material with extreme care. Thiodan is extremely toxic to fish and wildlife.
First Oriental Fruit Moth and Borer Spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • [4]Guthion Solupak or [4]APM 50 W or [4]Sniper 50 W	93 mL 67 mL 1.25 kg 0.77 kg 0.77 kg 0.77 kg	Widespread resistance has developed in Niagara to organophosphate insecticides Guthion/APM and Parathion, and the carbamates including Sevin and Lannate. Where resistance is not a problem, use Imidan or Guthion.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/1,000 L	Comments
Lesser peachtree borer	• Thiodan 4 EC or Thiodan 50 WP or Endosulfan 50 W	1.75 L 1.50 kg 1.50 kg	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each **Oriental Fruit Moth Spray** in the 2nd year. Borers invade trunks from the ground level up and may complicate canker infections. The problem appears to be more severe in southwestern Ontario. Insecticides for OFM help control borer if trunk coverage is thorough.
Green peach aphid	• [3] Pirimor 50 DF	180 g	Green peach aphid may colonize and stunt new growth. Begin monitoring mid to late May for this pest. Apply controls when 30% of terminals are infested.
Second Oriental Fruit Moth and Borer Spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • [4]Guthion Solupak or [4]APM 50 W or [4]Sniper 50 W	93 mL 67 mL 1.25 kg 0.77 kg 0.77 kg 0.77 kg	See comments on organophosphate resistance under **First Oriental Fruit Moth Spray**.
Lesser peachtree borer	• Thiodan 4 EC or Thiodan 50 WP or Endosulfan 50 W	1.75 L 1.50 kg 1.50 kg	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each **Oriental Fruit Moth Spray** in the 2nd yr.
Green peach aphid	• [3]Pirimor 50 DF	180 g	
Third Oriental Fruit Moth and Borer Spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • [4]Guthion Solupak or [4]APM 50 W or [4]Sniper 50 W	93 mL 67 mL 1.25 kg 0.77 kg 0.77 kg 0.77 kg	See comments on organophosphate resistance under **First Oriental Fruit Moth Spray**.
Lesser peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4 EC	1.50 kg 1.50 kg 1.75 L	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each **Oriental Fruit Moth Spray** in the 2nd yr.

Disease Control

Peach Canker

The following practices prevent peach canker.

When pruning

- Avoid cutting into the collar area of the branch or limb where it meets scaffolding or the trunk of the tree. When the collar area is injured or cut, the healing process is delayed or impaired, because wounded periderm tissues are located primarily in the collar region.

At planting time and first year

- Plant good nursery stock. Use Thiodan dip for borer control. See *Guidelines for Protecting Young Non-Bearing Peach Plantings* on page 170.
- When pruning at planting time, remove all poor angles and weak side branches.
- Go over trees in mid-June and remove all dead wood and obviously poorly angled live branches.

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[4]Minimum period for re-entry is 48 hrs. [5]Minimum period for re-entry is 72 hrs. [6]Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

- Apply sprays for fruit moth, peachtree and lesser borer.
- Sow a cover crop (early July).
- Protect trees from rabbits and mice.

Second and following years

- Apply nitrogen fertilizers early (March, April) to bearing trees. Avoid late applications of manure.
- Prune as late in the spring as possible. Prune 2- and 3-yr old trees after bloom.
- Do not prune immediately preceding rains.
- Remove all dead wood and poorly angled branches.
- Go over scaffolds in June and remove dead wood and poorly placed new growth.
- Apply sprays for fruit moth, peachtree borers, plant bugs and brown rot.
- Sow a cover crop (early June).
- Protect trees from rabbits and mice.

Non-Bearing Peach Plantings

Mites

Mites are usually not a problem on non-bearing trees. Trees can tolerate about 30 mites/leaf. See also *Insects and Mites in Tender Fruit* on page 154.

Cankers

Perform canker surgery and dead wood removal in June or July when rapid growth and the healing of the tree can take place. Conduct surgery when there is a forecasted period of dry weather.

During surgery remove all diseased bark around the canker and about 3–5 cm of healthy tissue from around the sides and ends, respectively. The resulting wound, when finished, should have a smooth margin and be slightly rounded above and below to favour rapid wound closure. Surgery sites in June and July heal best if left uncovered without wound dressing. Some pruning paints seal in moisture, providing an ideal environment for fungal infection.

Southwest Injury and Rodent Control

Use latex paint-based repellent. Paint the whole trunk, plus the base of major scaffolds. See *Control of Southwest Injury on Fruit Trees* on page 50 for details.

See *Stone Fruit Diseases* on page 151. See *Insects and Mites in Tender Fruit* on page 154.

Thinning Peaches

Peach thinning is an essential orchard management practice and is necessary to obtain good-sized, quality fruit.

Most peach cultivars have the potential for over-cropping, which results in limb breakage, reduced fruit size and quality, loss of tree vigour, shortened orchard life, and increased pest management problems. Optimum fruit load depends on cultivar, tree vigour, orchard management (tree spacing, irrigation, pruning), tree age, and tree health (free from winter injury and peach canker).

Often fruit spacing receives more attention than fruit load. Orchardists tend to think of spacing the fruit 15–20 cm apart. Distance between fruit is not too critical as long as clusters are broken up and fruit is separated. Tree crop load (kg/tree or number of fruits/tree) is a more important consideration. As an example, a yield of 18–27 tonnes/ha (8–12 t/acre) in an orchard with a tree density of 490 trees/ha (200 trees/acre) requires about 200–300 fruit/tree, assuming an average fruit size of 4–7 fruit/kg (2–3 fruit/lb). With current emphasis on increased fruit size for better marketability and trends towards higher tree densities, fruit loads of 175–200 fruit/tree may be more ideal, at least for cultivars that normally produce large fruit.

Some factors that must be taken into consideration are:

Timing — Start thinning near the end of June drop (about mid-June) when you can determine which fruits will abort and fall on their own. Thinning at early fruit development or even blossom time is more beneficial than late thinning. However, it is difficult to get a true assessment of crop load before June drop occurs. Thin early-ripening cultivars first in order to obtain proper fruit size. In some years, a follow-up hand thinning may be necessary.

Pruning — An essential part of the fruit-thinning procedure. A considerable amount of the fruit-bearing surface is selectively removed, which also removes some of the excess crop. Normal fruit thinning must follow to avoid over-cropping.

Cultivars — Cultivar selection over the years has tended towards larger fruit. Earlier ripening cultivars frequently bear a fairly high percentage of fruit having split pits. Growers often lightly-thin once, early, to remove some crop load, then a 2nd time to selectively remove split-pit fruit. Recently introduced, Harrow Diamond is the earliest commercial-ripening cultivar with few split-pit fruit. This cultivar must be well thinned to obtain suitable size. There is little likelihood of over-thinning early cultivars when the set is heavy. Heavy-setting, hard-to-size cultivars such as Redhaven require heavier thinning than easier-to-size types like Vivid and Loring. As a rule of thumb, however, late maturing cultivars with a good, uniform set are thinned 10–13 cm apart in order to produce good-sized fruit. Cultivars are different and are thinned according to their individual requirements.

Irrigation — In many commercial farms irrigation is used to enhance fruit size, especially during long periods of dry conditions. Start irrigating early in the season and continue a regular schedule based on rainfall. Growers without irrigation may, in some years, need a 2nd thinning during July to attain marketable fruit size.

Thinning Methods — Thinning is most commonly accomplished by hand with manual labour. Physical aids such as a child's plastic bat, a rubber hose mounted on a bamboo pole or broom handle, or a plastic rake manufactured for this purpose are useful to remove large quantities of fruit in a hurry. Initial thinning is often followed up by a "touch-up" thinning to assure that fruit numbers/tree produce good-sized fruit for the cultivar and orchard condition. It is important to ensure that clusters are broken up and fruit separated. If the set is spotty on the tree, more fruit may be left on the heavy-set branches.

Other methods that have been investigated are:

Mechanical trunk shaker: This method of shaking fruit when they are walnut-size is erratic and can result in over-thinning. The negative, long-term effect on the root system has yet to be determined.

Rope thinning of blossoms: Tree training systems have not yet been properly developed to adapt rope thinning. Only the older, standard pruning style using mature trees has been tried with moderate success in growers' orchards. Timing is also a problem because it conflicts with pruning.

Chemical thinning: There are presently no chemicals registered for fruit thinning peaches in Ontario.

Any of the above methods must be supplemented by touch-up hand thinning.

Pear Calendar

Read the label and follow all safety precautions.
Rates are based on tree size of 4.5–5.5 m high. Refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant			
Scale insects Pear psylla	• Superior 70 Oil	60 L	Apply full rate of oil in 2,000–3,000 L of water/ha. 3,000 L gives best results. Good coverage is essential. Do not apply full rate of oil more than once/season.
Green Tip			
Scab	• Equal 65 WP • Captan 80 WDG or [4]Maestro 80 DF • Dikar • Benlate T-N-G plus Manzate 200 WP	3.25 kg 3.60 kg 3.75 kg 6.75 kg 550 g 3.25 kg	It is important to start scab control early and repeat the spray if weather remains wet. Do not use Captan or Maestro on d'Anjou pears. When Dikar is used in a full season program at 10-day intervals, it controls pear scab and nymphal stages of pear psylla. It also suppresses European red mite and rust mite populations. It must not be used within 45 days of harvest. Higher water volumes aid in mite suppression. Alternate Benlate-Manzate with full rates of Captan, Dikar, or Equal to avoid Benlate resistance.
European red mite Pear psylla	• Superior 70 Oil	60 L	Best applied at or near **Green Tip** for mites. Good coverage is necessary. Oil is not effective for rust mite control. Do not apply full rate of oil more than once/season.
Prebloom (as blossoms show white at tips)			
Scab	Use one of the materials listed for scab control under **Green Tip.** Repeat spray if weather remains wet.		
Rust mite European red mite	• Carzol SP • Kelthane 50 W	1.10 kg 3.25 kg	Carzol is harsh on beneficial mites and honey bees. Some resistant mites may be present when Kelthane has been used for 4 or more yrs and an alternative miticide is advisable.
Pear psylla	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Thiodan 50 WP or Endosulfan 50 W • [3]Pyramite	2.30 kg 2.30 kg 2.30 kg 6.75 kg 6.75 kg 600 g	To avoid resistance problems, pyrethroids are not recommended at this time. Refer to comments at **First Cover.** Guthion and APM also controls green fruitworm. Maximum 2 applications Pyramite/yr.
Green fruitworm Obliquebanded leafroller	• Dipel 2X DF or Foray 48BA • Imidan 50 WP • [4]Guthion Solupak or [4]APM 50 W or [4]Sniper	1.12 kg 2.80 L 3.75 kg 2.30 kg 2.30 kg 2.30 kg	These products only suppress obliquebanded leafroller. B.t. formulations such as Dipel and Foray are most effective when larvae are actively feeding and weather is warm and dry for 3 days after application. 2– 3 applications of B.t. may be required to cover the extended emergence of overwintering larvae.
Plant bugs	• Thiodan 50 WP • or Endosulfan 50 W	4.50 kg 4.50 kg	Thiodan helps to control psylla.

All pear varieties in Ontario are commercially self-unfruitful, and mixed plantings are necessary. Insects are required for cross-pollination. Honeybees do not find pear blossoms as attractive as most other fruit. Careful timing of the introduction of honeybees to orchards is necessary. Use up to 8 hives/ha when the orchard is about 25% in bloom. The use of pollen inserts will help to overcome this problem.

Bloom

Do not apply insecticides while pears are in bloom.
See *Bee Poisoning* on page 58.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Fire blight	• Streptomycin 17	600 g/1,000 L	Sprays are most effective when applied dilute (high volumes of water prior to a wetting period). Use alone for best results. Because Streptomycin 17 is UV light sensitive it is only effective for 2–3 days if warm wet conditions (above 20°C) prevail. 2–4 sprays during the bloom may be required for fire blight control. To avoid resistance use a maximum of 4 sprays/season. (See *Fire Blight of Pear* on page 178).
Petal Fall			
Pear psylla Plum curculio	• [3]Agri-Mek 1.9 EC	1.00 L	Thiodan and Endosulfan are not registered for plum curculio control. **Do not use Agri-Mek within 14 days of a Captan application.** Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L superior oil and a minimum of 1,000 L of water/ha. Apply when majority of population is in the nymphal stage. May cause russeting to d'Anjou and other sensitive varieties. To prevent or delay resistance, do not apply Agri-Mek more than once/season. Ideally, alternate yearly with other insecticides (e.g. Mitac). Agri-Mek will not control plum curculio. Maximum 2 applications Pyramite/yr.
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50W	2.30 kg	
	or [4]Sniper	2.30 kg	
	• Thiodan 50 WP	6.75 kg	
	or Endosulfan 50 W	6.75 kg	
	• [3]Pyramite	600 g	
Rust mite European red mite	Add one of miticides listed in **Prebloom.**		A single miticide applied at **Prebloom** or at **Petal Fall** is necessary for good mite control. Rust mite must be controlled no later than **Petal Fall** to avoid russetted fruit at harvest. Alternate miticides.
Leaf spots Scab	Add one of the fungicides listed for scab at **Green Tip**.		If wet weather persists, additional sprays will be needed for scab control before **First Cover.** Where there is a problem, spray at **Petal Fall** and **First Cover.** A dilute spray is necessary for good control.
Special Spray			
Mealybug	• [6]Parathion 15 W	2 kg/1,000 L	Where there is a problem spray at **Petal Fall** and **First Cover.** A dilute spray is necessary for good control.
Codling moth	• Imidan 50 WP	3.75 kg	Codling moth may cause economic fruit losses if pear plantings are located near wild apple, pear and other hosts infested with codling moth. The use of Mitac and Agri-Mek in pear psylla programs provides no protection of fruit against codling moth. For sites with a history of codling moth damage, apply 1 of these insecticides. Use codling moth timing as recommended for apple.
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper	2.30 kg	
First Cover (about June 25)			
Pear psylla	• [7]Mitac WP	2.50 kg	Apply Mitac, like other products, when the majority of the population is in early instar stages. Use Mitac only once/season and when populations of psylla are high, e.g., greater than 25 active/sucker. Where plum curculio is a later season problem, use 1 of the materials recommended at **Petal Fall.** Mitac also controls European red mite. Resistance to pyrethroid insecticides (Decis, Ripcord, Cymbush, Pounce, Matador) is widespread. Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L Superior Oil and a minimum of 1,000 L of water/ha. Apply when majority of population is in nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. Do not use within 14 days of a Captan application. Do not apply more than once/season. Ideally, alternate yearly with other insecticides (e.g. Mitac). Agri-Mek will not control plum curculio. Maximum 2 applications Pyramite/yr. [7] *See product label for specific re-entry requirements and precautions.*
	• Thiodan 50 WP	6.75 kg	
	or Endosulfan 50 W	6.75 kg	
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper	2.30 kg	
	• Decis 5 EC	350 mL	
	• Ripcord 400 EC	250 mL	
	or Cymbush 250EC	280 mL	
	• Pounce	520 mL	
	• [3]Matador 120 EC	83 mL	
	• [3]AgriMek 1.9 EC	1.0 L	
	• [3]Pyramite	600 g	
Scab	Add one of the fungicides listed under **Green Tip**. Reduce rate of Equal to 2.25 kg/ha in cover sprays.		
Obliquebanded leafroller	• Dipel 2X DF	1.12 kg	Resistance to the organophosphates such as Imidan and Guthion/APM is becoming more widespread. All of these products will only suppress leafroller populations.
	or Foray 48BA	2.80 L	
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper	2.30 kg	
	• Imidan 50 WP	3.75 kg	

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Special Spray			
Blister mite	• Sevin XLR Plus	6.25 L	
	• Thiodan 50 WP	4.50 kg	
	or Endosulfan 50 W	4.50 kg	
Summer Sprays			
Pear psylla	• [7]Mitac WP	2.50 kg	Apply Mitac, like other products for psylla control, when majority of the population is in early instar stages. Use Mitac only once/season and when population of psylla are high, e.g., greater than 25 active/sucker. Mitac also controls European red mite. Guthion or APM are the most effective summer insecticides to control codling moth, if it should become a problem. Maximum 2 applications Pyramite/yr.
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper	2.30 kg	
	• Thiodan 50 WP	6.75 kg	
	or Endosulfan 50 W	6.75 kg	
	• Decis 5 EC	350 mL	
	• Ripcord 400 EC	250 mL	
	or Cymbush 250 EC	280 mL	
	• Pounce	520 mL	
	• [3]Matador 120 EC	83 mL	
	• [3]Pyramite	600 g	[7] *See product label for specific re-entry requirements and precautions.*
Codling moth	• Imidan 50 WP	3.75 kg	Codling moth may cause economic fruit losses if pear plantings are located near wild apple, pear and other hosts infested with codling moth. Mitac and Agri-Mek in pear psylla programs provide no protection of fruit against codling moth. For sites with a history of codling moth damage, apply 1 of these insecticides. Use codling moth timing as recommended for apple.
	• [4]Guthion Solupak	2.30 kg	
	• or [4]APM 50 W	2.30 kg	
	• or [4]Sniper	2.30 kg	
Mites	• Kelthane 50 W	3.25 kg	Examine orchards for red mite and rust mite injury about July 15–20 or 10–15 days after using a pyrethroid. Do not apply closer to harvest than the number of days given in Table 10–14 on page 177. Alternate miticides. Carzol is harsh on beneficial mites. Maximum 2 applications Pyramite/yr.
	• Carzol SP	1.10 kg	
	• [3]Pyramite	300 g	
Second Cover			
Scab	Add one of the fungicides listed under **Green Tip**. Reduce rate of Equal to 2.25 kg/ha in cover sprays. Dikar and Manzate have a 45 days-to-harvest interval.		
Sooty blotch	• Captan 80 WDG	3.60 kg	Repeat spray for sooty blotch 2 weeks later. Do not use Captan or Maestro on d'Anjou pears.
	or [1]Maestro 80 DF	3.75 kg	
	• Zineb 80 W	6.00 kg	
Special Sprays (about mid-Aug. and early Sept.)			
Codling moth	• [4]Guthion Solupak	2.30 kg	Codling moth can infest pear as maturation and ripening begins. Bosc pears can be heavily infested and may require 2 preharvest sprays about 2 weeks apart. For Bosc, Anjou and Bartlett a spray 7–10 days prior to harvest is recommended in orchards adjacent or near peaches.
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper	2.30 kg	
	• Imidan 50 WP	3.75 kg	
Obliquebanded leafroller	• Dipel 2X DF	1.12 kg	
	or Foray 48BA	2.80 L	
	• [4]Guthion Solupak	2.30 kg	
	or [4]APM 50 W	2.30 kg	
	or [4]Sniper 50 W	2.30 kg	
	• Imidan 50 WP	3.75 kg	
Postharvest Treatment			
Blue mould	Mertect SC	500 mL/ 500 L water	For use in dip tank or drencher. Continuous agitation required. Follow label instructions. Does not control any blue mould (Penicillium) or grey mould (Botrytis) which is resistant to benzimidazole fungicides (e.g., Benlate).

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[4] *Minimum period for re-entry is 48 hrs.* [5] *Minimum period for re-entry is 72 hrs.* [6] *Minimum period for re-entry is 7 days.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Use this table as a guide, but refer to product label for specific information.

TABLE 10–14. Days to Harvest Intervals for Products Used on Pears

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
AGRI-MEK 1.9 EC	28	ENDOSULFAN 50 W	15	MITAC W	14
APM 50 W INSTAPAK	7	EQUAL 65 WP	7	PARATHION 15 WP	14
BENLATE T-N-G	1	FORAY 48 BA	1	POUNCE	7
CAPTAN 80 WG	7	GUTHION SOLUPAK	14	PYRAMITE	25
CARZOL SP	1	IMIDAN 50 WP	1	RIPCORD 400 EC	7
CYMBUSH 250 EC	7	KELTHANE 50 W	7	SNIPER	14
DECIS 5 EC	7	MAESTRO 80 DF	7	STREPTOMYCIN 17	30
DIKAR	45	MANZATE 200 WP	45	SUPERIOR 70 OIL	PB
DIPEL 2X DF	1	MATADOR 120 EC	7	THIODAN 50 WP	15
		MERTECT SC	PH	ZINEB 80W	45

PB: prebloom only
PH: post harvest

Guidelines for Protecting Young Non-Bearing Pear Plantings

The following program provides protection when needed for newly planted trees. Other protective measures include the removal of neglected fruit trees in the area, careful selection of intercrops (where used) and a clean, weed free environment. Rates are for dilute spraying. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Materials	Amount/ 1,000 L	Comments
Fire blight	• Streptomycin 17	600 g	Avoid excess nitrogen applications. Conduct regular leaf analysis. See *Fire Blight of Pear* on page 178.
Pear psylla	• Thiodan 50 WP or Endosulfan 50 W	1.50 kg 1.50 kg	If nymphs are observed, spray when 75% of the petals have fallen in nearby bearing orchards.
Leaf-feeding insects	• Imidan 50 WP	1.25 kg	Apply at any time when small caterpillars are feeding.
Pear psylla (summer broods)	• Thiodan 50 WP or Endosulfan 50 W	1.50 kg 1.50 kg	Target early nymphal stages.
European red mite	• Carzol SP	0.37 kg	Check foliage frequently and spray if 7–10 mites/leaf are observed or at 1st sign of leaf bronzing.

Pear Diseases

Fabraea Leaf Spot

Fabraea leaf spot, caused by the fungus *Fabraea maculata*, has increased in Ontario pear orchards recently. The disease is particularly severe during warm, wet and humid growing seasons following mild winters and wet springs.

Fruit and leaves are susceptible to infection throughout the growing season. In the spring, reddish-purple pinpoint spots appear on both the lower and upper surface of young leaves. The spots enlarge and become brown and necrotic, sometimes surrounded by a yellow chlorotic halo. Severely infected leaves turn yellow and drop prematurely. Sunken brown lesions may form on fruit and cause it to crack.

The disease overwinters on leaves and in superficial twig cankers. Spores are dislodged and spread by rain splash. Infections occur within 8–12 hr, depending on the length of the leaf wetness period and temperature. Lesions appear 7 days after infection.

Disease management is more successful when the primary source of inoculum is eliminated. In small orchards, leaves can be raked or removed from the orchard. For larger plantings, mowing or chopping fallen leaf litter speeds up the decomposition process and reduces inoculum.

There are no fungicides registered for Fabrea leaf spot control. Some fungicides used to control pear scab help suppress this disease.

Pear Scab

Pear scab, caused by *Venturia pirina*, has a biology and disease cycle similar to apple scab caused by *Venturia inaequalis*. (See *Managing Apple Scab* on page 77.) The pathogen that causes pear scab does not infect apples and vice versa.

Scab symptoms first appear as velvety black spots on young pear fruit. Severely infected fruit drop prematurely. Infected fruit that remain on the trees are often deformed with brown, scabby lesions. Under optimum environmental conditions, the initial lesions produce spores that cause secondary infection. Pinpoint scab lesions may develop on maturing fruit late in the season or after they are placed in cold storage.

Management strategies are focused on reducing overwintering inoculum in leaf litter and primary infections during the spring. Once primary infections are controlled, secondary infection is also limited and the disease will not become serious. Cultural practices that promote the rapid decomposition of leaf litter on the orchard floor reduce the number of overwintering spores.

For successful scab control during wet weather, schedule fungicide applications in the spring, beginning at green tip and continuing through bloom, petal fall and first cover.

Fire Blight of Pear

Fire blight can be a major disease problem for Ontario pear growers. The following practices can help reduce blossom and shoot blight infection.

Cultural Practices

Avoid applying excessive amounts of nitrogen fertilizer in the spring. Succulent, rapidly growing shoots and suckers are more susceptible to fire blight infection.

Remove all diseased wood in the dormant season (Jan. or Feb.) when temperatures are below freezing. Patrol orchards at least twice/week when blossom and shoot blight symptoms are predicted to occur. When the number of strikes is low remove these new infections from the orchard to avoid further spread of the disease. Use pruning tools to remove new infections at least 30–45 cm below discoloured wood.

Disinfect pruning tools by mixing 1 part household bleach in 4 parts water. After use, wash and oil tools to prevent rust. Denatured alcohol (ethanol) is a better disinfectant than the bleach solution and does not rust tools.

Remove secondary blossoms before they become infected, reducing the potential for fire blight. Secondary blossoms on Bartlett pear probably pose the greatest risk for fire blight infections, but are often too numerous to remove.

Chemical Control

In spring, warm temperatures (18°C or greater) and moisture (rain or heavy dew) favour infection of blossoms. When these conditions are predicted, and they persist through the blossom period, protect the blossoms with Streptomycin 17 at 100 ppm (100 ppm = 600 g product/1,000 L water). Spray during slow drying conditions. Spray is most effective when applied dilute (high volumes of water) prior to a wetting period. For best results use Streptomycin 17 alone in the tank. Because it is sensitive to ultraviolet light, Streptomycin 17 is effective for only 2–3 days. If warm, wet conditions (above 18°C) continue, reapply after 2–3 days to protect newly opened blossoms. Two–4 sprays during the bloom period may be necessary to protect blossoms against fire blight infection.

In non-bearing orchards, copper sprays may be substituted for Streptomycin 17. However, copper sprays are less effective than Streptomycin 17 for controlling fire blight. Mix copper sprays with lime according to label directions. For more information on registered formulations, rates and mixing instructions see *Use of Copper Products on Fruit Crops* on page 51.

If hail or damaging winds occur during the growing season, apply Streptomycin 17 within 12 hr to prevent serious damage to the fruit and trees. Beyond 24 hr, streptomycin is not effective. Ensure a 30–day to harvest interval on pears.

Predicting Fire Blight Infections

Maryblyt is a computer modeling program. It is designed to predict fire blight infection by using daily minimum and maximum temperatures, rainfall amounts and wetness and forecasted weather. Advanced warning (1–4 days) of fire blight infection is provided during the critical susceptible growth stages. The most precise prediction for your farm is obtained when you use data from your farm with Maryblyt. Copies are available from Gary Lightner, 293 Tuscawilla Hills, Charles Town, WV 25414, tel: 540-869-8372, gary_lightner@hotmail.com, gary.lightner@fishersci.com.

Blue Mould and Grey Mould in Stored Pears

Under certain conditions rot can develop on pears during storage. Disease organisms are common in and around grading lines, work areas and storages. Fungi causing blue mould (*Penicillium*) and grey mould (*Botrytis*) are spread in air currents and by water.

Infection of pears most commonly occurs after harvest through stem punctures, wounds, skinbreaks and heavy bruises. These fungi can be transferred from contaminated bins, water used for dipping or drenching, and grading equipment.

Rot develops faster if the infected pears are delayed going into storage, cooled slowly in storage, stored for a longer period, or held at warm temperatures after removal from storage.

Reducing Disease Development

Careful handling during and after harvest to minimize stem punctures, skin breaks and bruising can greatly reduce the number of infection sites on the fruit.

At the storage, lift truck operators must also move the bins with a minimum of jolting and dropping. Refrigerate the fruit as quickly as possible. Adequate refrigeration capacity for each storage room is required. Modern refrigeration facilities and the use of controlled atmospheres also reduce the development of fruit rot.

Sanitation in the handling/grading area is very important. Careful and frequent removal and disposal of rotted fruit from the premises greatly reduces the dispersal and spread of disease organisms within the building.

Frequent changing of the water used for dipping or drenching reduces the accumulation of fungal spores in the water, greatly reducing the risk of fruit infection.

Thinning Pears

The major pear cultivars grown in Ontario benefit from fruit thinning. The thinning of fruit is particularly beneficial during seasons of heavy fruit set or inadequate moisture. Bartlett and Bosc can set fruit in clusters of 3–5 fruit/spur. If fruit set is excessive, reduce the number of fruit/cluster to 1 or 2. If the set on the tree is not excessive, multiple fruit/cluster will reach a satisfactory size without fruit thinning. To obtain large sized fruit, irrigating after shuck split, during extended dry periods in mid summer and a few weeks before harvest is the most beneficial.

Start thinning near the end of June drop (mid-June) when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Pears on dwarfing rootstock must be thinned in order to obtain a high percentage of marketable fruit and prevent limb breakage. De-fruit trees during the first 4 yr of establishment. Reduce the crop to 1 fruit/spur, spaced 12–15 cm apart during normal years. The combination of proper fruit thinning and irrigation has the most positive results on pear fruit size.

Response of pears to chemical agents, under Ontario conditions, is inconsistent between years. Try chemical thinning on a small scale until you have evaluated response in relation to tree vigour, cultivar, and fruit size.

Use either NAA (*naphthaleneacetic acid*) or NAD (*naphthaleneacetamide*) for chemical thinning. Suggested rates are: NAA at a concentration of 15–20 ppm approximately 3–6 days after petal fall, or NAD at 10 ppm, 6–9 days after petal fall, depending on tree vigour and amount of thinning desired. For specific application instructions consult the product label.

Plum Calendar

Read the label and follow all safety precautions.
Rates are based on tree size of 4.5–5.5 m high. Refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
Green Tip (just as buds are bursting)			
European red mite Scale insects	• Superior 70 Oil	60 L	Spray on a calm day to improve coverage.
Prebloom (when blossoms show white)			
Brown rot	• [5]Topas 250 E • Rovral • Captan 80 WDG or [4]Maestro 80 DF • Sulphur 92 WP • Funginex 190 EC • [4]Vangard 75 WG	500 mL 1.50 kg 4.50 kg 4.50 kg 19.50 kg 2.50 L 370 g	To help control brown rot, knock off fruit mummies when pruning. Cultivate entire orchard before bloom. To avoid resistance, alternate between fungicides and do not use more than 2 applications of Rovral or Vangard/season. See *Brown Rot Control* on page 151. Sulphur helps control rust mites on European plums and prunes. Captan or Maestro may cause injury under some circumstances. Injury has occurred on Grand Prize, Early Golden, Shiro, Burbank and Ozark Premier. Make 2–3 applications from early to full bloom.
Black knot	• Captan 80 WDG or [4]Maestro 80 DF	4.50 kg 4.50 kg	Destroy affected wild and neglected plums near orchard. Cut out and burn all black knots before March. Make the cut 15 cm below the swelling. Collect and burn all prunings with knots. Knots left lying on the ground are a source of spores that start new infections. Inspect all plums in early summer for new knots and those missed. Cut these out and burn them. European plums, prunes and damsons are most susceptible. Apply fungicide sprays to protect the developing shoots between the popcorn stage (prebloom) and 1st cover every 3–5 days in wet weather. Spore release may be delayed in dry springs when rains are delayed until after bloom. Under these conditions extend fungicide coverage to 1st cover.
Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.			
Bloom			
			Do not apply insecticides while plum trees are in bloom. See *Bee Poisoning* on page 58.
Brown rot (Blossom blight)	Use one of the fungicides listed under **Prebloom**.		
Shuck (when most of the shucks are off)			
Brown rot	• [5]Topas 250 E • Rovral • Sulphur 92 WP • Captan 80 WDG or [4]Maestro 80 DF • [4]Vangard 75 WG	500 mL 1.50 kg 19.50 kg 4.50 kg 4.50 kg 740 g	Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances. To avoid resistance, alternate between fungicides and do not use more than 2 applications of Vangard or Rovral/season. See *Brown Rot Control* on page 151.
Black knot	• Captan 80 WDG or Maestro 80 DF	4.50 kg 4.50 kg	Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances.
Plum curculio	• [4]Guthion Solupak or [4]APM 50 W or [4]Sniper • Imidan 50 WP • [6]Parathion 15 W	2.30 kg 2.30 kg 2.30 kg 3.75 kg 5.25 kg	If temperatures are high, spray when the shucks split.
European red mite	• Kelthane 50 W	3.25 kg	If oil was not used at **Green Tip** a spray for mites is due at this time.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
First Cover (12 days after Shuck)			
Brown rot Leaf spot Black knot	Use one of the fungicides listed under **Shuck.**		Captan or Maestro may cause leaf injury and spotting on the fruit on Stanley and Japanese plums under some circumstances.
Plum curculio	Use one of the insecticides listed under **Shuck.**		
Summer Spray			
European red mite	• Kelthane 50 W	3.25 kg	
Second Cover			
Brown rot	• [5]Topas 250 E • Rovral • Sulphur 92 WP • Captan 80 WDG or [4]Maestro 80 DF • [4]Vangard 75 WG	500 mL 1.50 kg 19.50 kg 4.50 kg 4.50 kg 740 g	During wet weather repeat applications between pickings. Check interval to harvest for materials. See Table 10–15 on page 181. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.
Prepick			
Brown rot	Use one of the fungicides listed under **Second Cover.**		
Special Sprays			
Aphids	• Thiodan 50 WP or Endosulfan 50 W • Diazinon 50 W or DZN 600EW	3.25 kg 3.25 kg 3.00 kg 2.50 L	Apply only if aphids are a problem. Very thorough coverage and calm warm conditions are needed for good control.
Apple maggot	• Diazinon 50 W or DZN 600 EW • Imidan 50 WP	3.00 kg 2.50 L 3.75 kg	If apple maggot has been a problem on blue plums and prunes, apply 2 or 3 sprays during July and Aug.
Peachtree borer Lesser peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4EC • Sevin XLR Plus	1.5 kg/1,000L 1.5 kg/1,000L 1.75L/1,000L 6.25 L	Apply 3 sprays, 3 weeks apart. Apply 1st spray 10 days after 1st adult catch in pheromone traps. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals and do not spray if fruit is to be harvested during this period.

Use this table as a guide, but refer to product label for specific information.

TABLE 10–15. Days to Harvest Intervals for Products Used on Plum

Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest	Product Name	# of days between last spray & 1st harvest
APM 50 W INSTAPAK	15	IMIDAN 50 WP	1	SEVIN XLR PLUS	2
CAPTAN 80 WDG	2	KELTHANE 50 W	7	SNIPER	15
DIAZINON 50 W	10	MAESTRO 80 DF	2	THIODAN 4 EC	15
DZN 600EW	10				
ENDOSULFAN 50 WP	15	MICROSCOPIC SULPHUR	1	THIODAN 50 WP	15
FUNGINEX 190 EC	C	PARATHION 15 W	14	TOPAS 250 E	3
GUTHION SOLUPAK	15	ROVRAL	1	VANGARD 75 WG	2

C: Do not apply later than recommended is calendar.

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[1] Minimum period for re-entry is 4 hrs. [2] Minimum period for re-entry is 12 hrs. [3] Minimum period for re-entry is 24 hrs.
[4] Minimum period for re-entry is 48 hrs. [5] Minimum period for re-entry is 72 hrs. [6] Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Disease Control for Plums

Heat Spot

High temperatures may cause purplish spots on plum and prune fruits that exude clear gum. These spots develop about 5–8 days after the hot spell. Summer cover crops and mulch help to reduce this physiological disease.

To reduce this disorder on prunes, spray with 4 kg of calcium chloride in 1,000 L of water during the period from early July to mid-Aug. Apply 3 sprays, 10–12 days apart.

See *Stone Fruit Diseases* on page 151.
See *Insects and Mites in Tender Fruit* on page 154.

Thinning Plums

In recent years, the market demand for larger fruit has placed more importance on fruit thinning, pruning and irrigation. Japanese plums require systematic fruit thinning; otherwise fruit size will be small and a biennial cropping will ensue. European plums grown for fresh market also require thinning in the years of heavy fruit set. Inadequate fruit thinning results in production of under-sized plums and, at times, fruit ripening on overloaded trees will be delayed. To obtain large-sized fruit, irrigate after shuck split, during extended dry periods in mid summer and a few weeks before harvest.

Start thinning near the end of June drop (early–mid June) when you can determine which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Fruit size thinning is preferred to conventional space thinning. Size thinning selectively removes small, weak, blemished or diseased fruit regardless of spacing of the fruits on the branches. The end result should be proper sizing of the fruit remaining on the tree.

11. Tree Nuts

Walnut Calendar

Read the label and follow all safety precautions.
For dilute spraying, refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
1st Pistillate Flower			
Walnut blight	• Clean Crop Copper	4.00 kg	Apply in sufficient water to ensure complete coverage. Do not apply more than 4 times/season. Do not apply after husks split. Do not apply within 40 days of harvest.
Summer Sprays			
Codling moth Filbert worm Walnut husk fly	• [4]Guthion 50 WP	2.25 kg	To time sprays accurately, monitoring of the pest is recommended. Do not apply after husks split. Do not use Guthion in back pack or home garden type sprayers.
Walnut blight	• Clean Crop Copper	4.00 kg	Apply in sufficient water to ensure complete coverage. Do not apply more than 4 times/season. Do not apply after husks split. Do not apply within 40 days of harvest.

Filbert/Hazelnut Calendar

Read the label and follow all safety precautions.
For dilute spraying, refer to *Guide for Spraying Fruit Trees* on page 19.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant			
Eastern filbert blight	• Guardsman Copper oxychloride 50	3.00 kg	Apply prior to bud break. Apply in sufficient water volume to ensure thorough coverage.
Postharvest			
Eastern filbert blight	• Guardsman Copper oxychloride 50	3.00 kg	Apply prior to fall rains and when 75% of leaves have fallen. Apply in sufficient water volume to ensure thorough coverage.

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[1]Minimum period for re-entry is 4 hrs. [2]Minimum period for re-entry is 12 hrs. [3]Minimum period for re-entry is 24 hrs.
[4]Minimum period for re-entry is 48 hrs. [5]Minimum period for re-entry is 72 hrs. [6]Minimum period for re-entry is 7 days.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

12. Weed Management for Fruit Crops

Principles of Integrated Weed Management

Integrated Weed Management (IWM) uses all available weed control strategies in the best possible way to manage weed populations. Such strategies include cultural, mechanical and chemical methods of weed control. All these practices are components of an IWM system. None of these control measures on their own can be expected to provide acceptable levels of weed control. Therefore, instead of relying on only one particular method of weed control, an IWM system uses a combination of methods to control weeds. By following the principles of an IWM system you can reduce the use of herbicides and at the same time obtain optimum economic returns.

Cultural Methods of Weed Control

Crop Rotation

Crop rotation involves alternating different crops in a systematic sequence on the same land. It is an important strategy for developing a sound, long-term weed control program. Weeds tend to thrive with crops of similar growth requirements as their own and cultural practices designed to contribute to the crop may also benefit the growth and development of weeds. Monoculture, that is growing the same crop in the same field year after year, results in a build-up of weed species that adapt to the growing conditions of the crop. When diverse crops are used in a rotation, weed germination and growth cycles are disrupted by variations in cultural practices associated with each crop (tillage, planting dates, crop competition, etc.).

Field Scouting

Field scouting is a key component of an IWM system. It involves the systematic collection of weed and crop data from the field (weed distribution, growth stage, population, crop stage, etc.). The information is used, in the short term, to make immediate weed management decisions to reduce or avoid economic crop loss. In the long term, field scouting is important in evaluating the success or failure of weed management programs and for making sound decisions in the future.

Cover Crops

The inclusion of cover crops such as rye, red clover, buckwheat and oilseed radish, or overwintering crops like winter wheat or forages in the cropping system, can suppress weed growth. Fast-growing crops or crops exhibiting allelopathic properties can also suppress weeds. Highly competitive crops may be grown as short duration "smother" crops within the rotation. Additionally, cover crop residues on the soil surface suppress weeds by shading and cooling the soil. When choosing a cover crop, always consider how the cover crop will affect the succeeding crop.

Intercropping

Intercropping involves growing a smother crop between rows of the main crop. Intercrops are able to suppress weeds. However, use caution when intercropping for weed control. The intercrops can greatly reduce the yields of the main crop if competition for water or nutrients occurs.

Nitrogen Fertility

Nitrogen fertilizer can affect the competition between crops and weeds and in the subsequent crops. For example, nitrate is known to promote seed germination and seed production in some weed species. Nitrogen fertilization may result in increased weed growth instead of increased crop yield. Selective placement of nitrogen in a band can favour the crop over the weed. Use of legume residues, as opposed to chemical nitrogen fertilizer to supplement nitrogen needs of the crop, can enhance weed suppression. Legume residues release nitrogen slowly with less stimulation of unwanted weed growth.

Planting Patterns

Crop population, spatial arrangement and the choice of cultivar (variety) affect weed growth. For example, studies show that narrow row widths and a higher seeding density reduce the biomass of later-emerging weeds by reducing the amount of light available for weeds located below the crop canopy. Similarly, fast growing cultivars can have a competitive edge over the weeds.

Tillage System

Tillage systems alter the soil seedbank dynamics and depth of burial of weed seeds. Studies show that almost 75% of the weed seedbank occurs in the upper 5 cm of soil in no-till fields. In the moldboard plow system however, the seedbank is more uniformly distributed over depth. Other conservation tillage systems are intermediate to these 2 systems.

Weed seedling emergence is often more uniform from shallowly buried weed seeds and this may result in better weed control. Weed seeds closer to the soil surface are more likely to be eaten or damaged by insects, animals, other predators and disease causing organisms.

Critical Period of Weed Control

The critical period of weed control is an important concept in IWM systems. This period has been defined as an interval in the life cycle of the crop when it must be kept weed-free to prevent yield loss.

This concept helps in determining the most effective time for non-residual postemergent herbicide applications, and reduces the practice of season-long residual herbicides, and unnecessary late applications of herbicides. The critical periods are defined relative to a crop growth stage to account for soil, weather and seasonal variations. The critical period is based on a yield loss of less than 5% due to weed interference. In other words, the crop has to be weed-free during these stages to prevent a yield loss of more than 5%.

If weeds have been controlled throughout the critical period, the weeds that emerge later will not affect yield and can be controlled prior to harvest with a harvest aid to burn down the weeds and desiccate the crop.

Horticultural fruit crops are very sensitive to weed competition, and need to be kept weed free from planting, emergence or budbreak, until the end of their **Critical Weed-free Period**. This differs slightly from the Critical Period for Weed Control, but is useful for crops where soil applied preemergent herbicides or cultivation are the main option for controlling weeds. If the crop is kept weed free for the **Critical Weed-Free Period,** generally no yield reduction should result. Again, weeds emerging after the critical weed-free period will not affect yield, but control efforts after this time may make harvest more efficient, or reduce weed problems in subsequent years in perennial crops.

Crop	Critical Weed-Free Period
Apples, new plantings	During May and June
Apples, bearing	Budbreak until 30 days after bloom
Strawberries, new	During May and June

Season-long weed control is not necessary!

Herbicide Band Applications

Alternative methods of weed control are available for all tillage systems. Studies have shown that banding herbicides will increase profitability. For example, selective application of herbicides in 30 cm bands on 76 cm wide corn rows represented an approximate 60% reduction in total herbicide applied into the environment. When complemented with inter-row cultivation, weed control and crop yields were maintained with lower herbicide costs.

Economic Thresholds

Weed economic thresholds help in determining if weed density and interference is sufficient to justify control measures, i.e., if the yield loss avoided is greater than the cost of weed control. The time at which weeds emerge relative to the crop is a major determinant of yield loss. Early weeds that emerge at the same time as the crop cause more yield loss than weeds emerging after the crop is established. For example, economic threshold studies conducted with redroot pigweed, ragweed and barnyard grass have found that the time of weed emergence in relation to the crop stage is more important than weed density when evaluating weed control options.

Critical periods and economic thresholds however do not apply in the same way to weeds, such as black nightshade, which may reduce the quality of the crop. In such cases the economic threshold may be zero.

Crop yield loss depends on the relative time of weed seedling emergence.

Managing Weeds Resistant to Herbicides

Resistance of weeds to herbicides is not a unique phenomenon. In fact, resistance to antibiotics, insecticides and fungicides is a world-wide problem that is not confined to any single pathogenic pest category.

Confirmed cases of pigweed, common ragweed, and eastern black nightshade resistance to the Group 2 family of herbicides have been found in Ontario. Some of these pigweed are also resistant to Group 5. Pigweed have also been found to be resistant to some Group 9 herbicides. These reports of resistance are in addition to an already extensive list of 212 weed species throughout the world that are resistant to at least one of the groups of herbicides listed in Table 12–1, *Herbicide Groups for Ontario,* on page 189. In Ontario resistance has been reported to Groups 2, 4, 5, 7, 9 and 22. In western Canada and the United States resistance has developed to Groups 1, 2, 3, 4, 5, 8 and 9.

NOTE 1: For control of a particular triazine-resistant species, select an effective non-triazine (non-Group 5) herbicide, or select a tank mix or premix with an effective non-triazine (non-Group 5) herbicide component. (See Table 12–1 on page 189.)

NOTE 2: Group 2 ALS resistant weeds -Biotypes of pigweed have been found that are resistant to one or more of the Group 2 herbicides. Resistant strains are difficult to distinguish from susceptible types. For control of a resistant species select an effective non-Group 2 herbicide, or select a tank mix or premix with an effective non-Group 2 herbicide component. (See Table 12–1 on page 189.)

Delaying Herbicide Resistance

Herbicide resistance results from a change in a weed population over time after repeated application of the same group of herbicides. The result is reduced weed control in the field. Resistance to different types of herbicides develops at different rates among weed species and populations. To prevent or slow the development of resistant weeds on your farm, take the following common-sense approaches.

Identify and Monitor:
Resistant weeds do not look different. Therefore, they are hard to identify. Furthermore, weed "escapes" are common after herbicide application. Resistance does not usually become obvious until 10%–30% of the population become resistant. Survey your fields regularly and apply the methods of diagnosing herbicide-resistant weeds to catch problems as they arise.

Prevent the Spread of Weeds:
When entering or leaving a field, clean all implements. Do not allow resistant weeds to go to seed.

Use Alternatives to Chemical Weed Control:
Combine mechanical weed control, such as rotary hoeing or cultivation, with chemical weed control where possible.

Rotate Crops and Herbicides:
Rotate herbicide usage so that the same herbicide group is not used year after year. One of the easiest ways to rotate to a new herbicide group is to rotate to a new crop. Then use a herbicide from an alternative group. Refer to Table 12–1 on page 189 for help selecting herbicides from different groups. This preplanning will prevent the same herbicide group from being used too often. When it is practical, use tank or formulated mixtures where both active ingredients within the tank act to kill the same weed in a completely different way.

Keep Records:
Keep accurate records of crop rotations and herbicide use in all your fields. It will be easier to plan long-term weed management strategies if you have good records.

Communication:
Stay in touch with farmer organizations, extension specialists, agribusiness, friends and neighbours about resistance problems they are encountering. Let your government or industry representative know about any cases of resistance so they can take the appropriate action to prevent spread of the weeds.

Diagnosing Herbicide-Resistant Weeds

Before assuming that any weeds surviving a herbicide application are resistant, rule out other factors that might have affected herbicide performance. Those factors are misapplication, unfavourable weather conditions, improper timing of herbicide application, and weed flushes after application of a non-residual herbicide. If resistance appears to be likely, check for the following:

- Are other weeds listed on the product label controlled satisfactorily? Usually, only 1 weed species will show herbicide resistance in any given field situation. Therefore, if several normally susceptible weed species are present, reconsider factors other than herbicide resistance.
- Did the same herbicide or herbicides from the same group (see Table 12–1 on page 189) with the same site of action fail in the same area of the field in the previous year?
- Do your records show extensive use of the same herbicide or herbicides from the same group year after year?

If 1 or more of these 3 situations apply, it is possible that the weeds are resistant to the herbicide. If resistance is suspected, control the weeds with a labeled herbicide from another group or use appropriate non-chemical weed-control methods to prevent the weeds from going to seed. Next, contact your weed specialist, herbicide supplier and the appropriate chemical company to develop a comprehensive weed-control program to manage the problem.

For more information on herbicide resistance see: OMAFRA Factsheet *Herbicide Resistant Weeds*, Order No. 01-023 and International Survey of Herbicide Resistant Weeds at: http://weedscience.com/.

Mechanical Methods of Weed Control

Preemergent or "Blind" Harrowing

Blind harrowing consists of waiting until after the crop has been planted, the seed is sprouted and the shoot is about to emerge. At this crucial time, the field is harrowed to kill the small weed seedlings that have already sprouted. The crop will emerge shortly afterwards, having gained a head start on the next generation of weeds. When properly carried out, this method can be most effective in controlling annual weeds in large seeded crops. In cereals, this blind harrowing will often provide adequate control of annual broadleaf weeds. In row crops, it can be used to keep weeds down until the crop plants are large enough to withstand other mechanical control methods. Any type of light harrow can be used. Blind harrowing must not be done on crops underseeded with grass or legumes.

Weeder Harrow

A weeder harrow has spring tines that are gentle enough not to harm the cultivated crop, while uprooting or covering the smaller annual weeds. Therefore, the relative size of the cultivated plants and the weeds is important. Weeder harrowing will be most successful when used as a "blind harrowing". Specially designed weeder harrows have been developed for use on field crops at various stages of development. They can be used most effectively on field vegetables, corn, soybeans and cereals.

Rotary Hoe

The rotary hoe has "fingers" that lift and mix the soil, uprooting small weeds. It is important to work at 10–20 km/hr for satisfactory results. Best results are obtained during late morning or afternoon hours when the hot sun can dry out the uprooted weeds. Also, crop plants tend to be more pliable at this time and injury is reduced. Rotary hoes tend to cause less crop damage than harrows. They are also effective in breaking up a soil crust and mixing surface-applied herbicides into the soil, which will improve the weed control. On light soils or under loose soil conditions, care must be taken to keep the rotary hoe working at a shallow depth.

Inter-Row Cultivation

Shallow inter-row cultivation or scuffling of row crops uproots small weeds and cuts off larger weeds. Various types of equipment can be used but, when shovels are used, allow for up to 50% overlap for thorough weed control. Shields should be used to protect small crops.

Row cultivation can be used profitably when applying herbicides. The herbicide may be more effective and the amount of herbicide used can be reduced, particularly with band applications. To provide adequate weed control in long-season crops, such as corn, scuffling will probably have to be done more than once. The 1st cultivation is the most crucial since weeds that escape this pass will usually grow to maturity. Here again the relative size of the crop to the weeds is important and probably the limiting factor in achieving 100% success. Blind harrowing, weeder harrows and rotary hoes are used first so that inter-row cultivators produce good results.

Mowing

Mowing or cutting weeds may control weeds in orchards, roadsides, lawns, etc. Harvesting hay or cereal crops also helps to control weeds. Mowing cereal stubble in early August can reduce weed growth and weed seed production, especially if the cereal had been underseeded to another crop such as red clover to compete with the new weed growth. The best time to mow perennial weeds is usually at the bud stage when root reserves are low and before seed set. Note that if a herbicide application is planned for later in the season, adequate time should be left for weed regrowth after mowing. For more information, see individual crop sections.

Use of Chemicals to Control Weeds

Chemicals may be used to control weeds either selectively in crops or non-selectively for the control of perennial weeds or on land not in crops, such as roadsides, fencerows and areas difficult to cultivate. The treatments listed in this publication are based on extensive field trials and observation on farms. Herbicides should not be used in cold frames or greenhouses unless specifically recommended.

Time of Herbicide Treatment in Crop Areas

The susceptibility of both crops and weeds to herbicides is related to the time of application. Therefore, it is important to use the chemical at a time when the crop is at its maximum resistance and the weeds are at their maximum susceptibility. This time will vary depending on the crop involved and the herbicide used. Terms describing the times at which herbicides may be applied, unless specified differently, refer to the stage of development of the crop plants.

Preplanting Treatments

Preplanting (PP) treatments are applied before the crop area is sown or planted. Some herbicides used in this way act on germinating seedlings, others may also kill weed seeds. When used preplanting, some herbicides must be thoroughly incorporated (PPI) with the soil soon after application. Directions for incorporation are given throughout the publication where these herbicides are recommended.

Preemergence Treatments

Chemicals used in preemergence (PRE) treatments are applied after seeding but before the specified weed or crop emerges. The chemicals may control weeds by (1) killing weed seedlings and/or (2) establishing a toxic layer of chemical on or near the soil surface in which germinating seeds and young seedlings cannot survive.

For successful preemergence treatments the crops must either be tolerant of the chemical at the seedling state or the toxicity must have disappeared before the crop emerges.

A smooth, well-prepared seedbed that is free of clods is necessary for best results. The surface soil should also be moist and the temperature favourable for the rapid germination of weed seed.

Postemergence Treatments

Postemergence (POST) treatments are applied after the crop and weeds have emerged. A selective chemical is used and the weeds are killed with little damage to the desirable plants. The types of weeds that may be controlled depend on (1) the susceptibility of the weed, and (2) the tolerance of the crop to the chemical. Treatment at the correct stage of crop development is important. Since most weeds are more susceptible to chemicals when young, early treatments will require less herbicide and will result in less damage to crops from weed competition and from spray equipment.

Sometimes a herbicide may be applied postemergence to the crop but preemergence to the weeds. For example, a crop may be cultivated, then a herbicide applied to the weed-free soil to control germinating weeds.

- Rainfall shortly after application of a postemergence herbicide may reduce weed control. See Table 12–2, *Interval Before Rainfall (Postemergent)*, on page 190.

TABLE 12–1. Herbicide Groups for Ontario

Group^1	Site of Action	Single modes of action (alphabetic order)	Two or more modes of action (alphabetic order)^2
1	Inhibitors of acetyl CoA carboxylase (ACCase)	Acclaim Super, Achieve, Assure, Assure II, Excel Super, Fusilade II, Hoe-grass, Poast Ultra, Select, Venture	
2	Inhibitors of acetolactate synthase (ALS) and also called acetohydroxyacid synthase (AHAS)	Accent, Arsenal, Classic, Elim EP, Muster, Pinnacle, Peak, Prism, Pursuit, Refine Extra, Reliance STS, Telar, Ultim	Broadstrike Dual Magnum(2,15), Broadstike Treflan(2,3), Cleansweep^3(2,6), Conquest^3(2,5), Fieldstar(2,4), Meridian Plus^3(2,6), Patriot(2,5), PeakPlus^3(2,4), Striker(2,4), Ultimax^3(2,4), Valor(2,3), Viper^3(2,14)
3	Microtubule assembly inhibitors	Bonanza, Dimension, Prowl, Rival, Treflan	Broadstrike Treflan(2,3), Valor(2,3)
4	Synthetic auxins	Banvel II, Caliber, Cobutox, Compitox, Covitox Plus, Dichlorprop-D, Diphenoprop, Dycleer, Dyvel, Embutox, Estaprop, Estasol, Estamine 2,4-D, Ester, Expedite Broadleaf, Garlon, Kil-Mor, Killex, Lontrel, MCPA, Mecoprop, Mecocrop 2,4-D, Mecoturf Plus 2,4-D, Meco-D, Par III, Premium 3-Way, Release, Savage, Sword, Target, Tordon 101 mix, Tricep, Turf Herbicide, Turf-Rite 2+2, Turboprop, Weedone CB	Buctril M(4,6), Calmix Pellets(4,5), Distinct(4,19), Fieldstar(2,4), Marksman(4,5), PeakPlus^3(2,4), Shotgun(4,5), Stampede CM(4,7), Striker(2,4), Ultimax^3(2,4),
5	Inhibitors of photosynthesis at photosystem II, Site A	Aatrex, Atrazine, Bladex, Gesagard, Hyvar X, Lexone, Princep, Pronone, Pyramin FL, Sencor, Simadex, Simazine, Sinbar, Velpar	Axiom(5,15), Calmix Pellets(4,5), Conquest^3(2,5), Converge(5,28), Krovar(5,7), Laddok(5,6), Marksman(4,5), Patriot(2,5), Primextra II Magnum(5,15), Shotgun(4,5),
6	Inhibitors of photosynthesis at photosystem II, Site A	Basagran, Basagran Forte, Lentagran, Pardner	Buctril M(4,6), Cleansweep^3(2,6), Laddok(5,6), Meridian Plus^3(2,6)
7	Inhibitors of photosynthesis at photosystem II, Site B	Afesin, Afolan, Betamix, Betanex, Herbec, Karmex, Linuron, Lorox, Patoran, Spin-Aid	Krovar(5,7), Stampede CM(4,7)
8	Conjugation of acetyl co-enzyme A	Avadex, Avenge, Betasan, Eradicane, Eptam, Ro-Neet	
9	Inhibitors of 5-enolpyruvylshikimimate-3-phosphate synthase (EPSP)	Clear-It, Credit, Expedite Grass & Weed, EZJect, Glyfos, Laredo, Renegade, Roundup, Touchdown, Vantage, Vision, Wrangler	Roundup Fast Forward(9,10)
10	Inhibitors of glutamine synthetase	Liberty, Ignite	Roundup Fast Forward(9,10)
11	Inhibitors of carotenoid biosynthesis	Amitrol, Amitrol-T	
14	Inhibitors of protoporphyrinogen oxidase (Protox)	Blazer, Goal, Reflex, Ronstar	Viper^3(2,14)
15	Conjugation of acetyl co-enzyme A	Devrinol, Dual Magnum, Dual II Magnum, Frontier	Axiom(5,15), Broadstrike Dual Magnum(2,15), Primextra II Magnum(5,15),
19	Inhibitors of auxin transport system	Alanap	Distinct(4,19)
20	Inhibits cell wall synthesis, Site A	Casoron	
22	Photo system I - electron diverters	Gramoxone, Reglone, Reward, Weed & Grass Killer	
23	Inhibitors of mitosis	CIPC	
27	others	Basamid, Krenite, Vapam	
28	Inhibitors of p-hydroxyphenyl pyruvate dioxygenase (HPPD)		Converge(5,28)

[1] Herbicide groupings for Ontario follow the Weed Science Society of America's nationally accepted grouping. Groups 12, 13, 16, 17, 18, 21, 24, 25 and 26 are not available in Ontario.

[2] Products with two or more sites of action are followed by the group numbers involved.

[3] Indicates herbicides sold as a co-pack under this trade name.

TABLE 12–2. Interval Before Rainfall (Postemergent)

Rainfall shortly after application of a postemergent herbicide may reduce weed control. This effect varies with the product, the formulation, the interval of time and the drying conditions between application and rainfall, as well as on the amount, intensity and duration of rainfall. The following information is based on the label information and additional detail supplied by the chemical industry. For more information, contact the manufacturer. In the case of a tank-mix, use the longest time interval of the products being considered.

0 to 15 Minutes	1 Hour	2 Hours	4 Hours	6 Hours	8 Hours
GRAMOXONE	POAST ULTRA	VENTURE L	2,4-D amine	AMITROL 240	AFOLAN F
REGLONE 240			IGNITE	BASAGRAN	LINURON 480
REWARD			LONTREL	CREDIT	LOROX
			ROUNDUP TRANSORB	GLYFOS	
			TROPOTOX PLUS	LEXONE	
			VANTAGE PLUS	ROUNDUP	
				SENCOR	
				TOUCHDOWN	
				VANTAGE	

Herbicides for Fruit Crops

Introduction

Read these notes together with the recommendations given later in this publication. Additional information on use, toxicity and safety precautions is given here. With a few exceptions the herbicides are listed under their common (generic) rather than their trade or product name. See Table 13–1, *Pesticides Used on Fruit Crops in Ontario,* on page 266, to determine the corresponding common name for a particular trade name. For example, Table 13–1 indicates that the trade name AFOLAN F has a common name of linuron; notes on AFOLAN F will be listed under linuron in this section. See *Notes on Adjuvants* on page 199 for information on adjuvants.

Complete information on each herbicide is available on the product label which is located on the herbicide container. The federal Pest Management Regulatory Agency also lists pesticide labels on their internet Web site at http://64.26.129.82/search/queryhit.htm. Many herbicide manufacturers also list product labels and/or Material Safety Data Sheets (MSDS) on their Web sites which are listed in Table 13–4, *Pest Control Product Companies,* on page 280.

2,4-D

Trade Names: 2,4-D AMINE, ESTEMINE (AMINE), ESTASOL (L.V.ESTER), IPCO 2,4-D AMINE 600 SAVAGE. **Chemical Family**: Phenoxy. **Crop and/or Non-Crop Registrations**: Cereals, turf, pastures, non-crop land, asparagus, field corn, cranberries, raspberries, strawberries, bearing fruit trees including apple, pear, peach, plum, apricot and cherries, water weeds and brush. **Sensitive Weeds**: Most broadleaf weeds, and brush. **Uptake and Translocation**: Readily absorbed through leaves or roots. Translocated primarily in phloem with the sugars but can also move with water in the xylem. Accumulation is primarily in the young, rapidly growing meristematic regions of roots or shoots. **Basis of Selectivity**: Differences in interception, penetration, translocation, metabolism and sensitivity of active sites lead to greater activity on broadleaf weeds compared to grasses. **Application Methods**: Postemergence (broadleaf weeds), stem-foliage or stem-basal (brush). **Residual Activity**: Half-life in soil is usually not longer than 1 or 2 weeks during the growing season due to rapid decomposition by soil micro-organisms. **Unique Characteristics**: All weeds are more easily killed when growing rapidly in moist soil. Unfortunately, some broadleaf crops, garden and ornamental plants are as sensitive to 2,4-D as many weeds and only a trace of the chemical as spray drift vapour drift or contaminant in soil or water may cause serious damage. Even crops that can be sprayed safely can be sensitive at some stages of growth or at excessive application rates; thus label precautions should be followed carefully. Amines and esters are the most common formulations of 2,4-D. The esters are the most active and can be used at the lower rates and for brush control. Since vapour drift is a potential problem with the ester formulations, only the amines should be used on lawns, or near gardens or susceptible crop areas. Low-volatile esters can be used by agriculturists or licensed applicators in areas where risk of damage to sensitive non-target vegetation is low. Recommendations are on the basis of acid equivalent; commercial products differ in their content of acid equivalent, which must be considered in determining the amount of product to use.

ADJUVANT

See *Notes on Adjuvants* on page 199.

AMITROLE

Trade Name: AMITROLE 240. **Chemical Family**: Triazole. **Crop and/or Non-Crop Registrations**: Preplant in wheat, barley, canola, field peas, corn, soybeans and white beans. Postharvest after any crop. In-season weed control in apples. Use in shelterbelts, non-crop areas, marshes and ditches. Spot treatment in pastures. **Sensitive Weeds**: Many annual and perennial broadleaf weeds and grasses including quack grass, dandelions, Canada thistle, sow-thistle, poison-ivy, poison-oak, toadflax, milkweed, hoary cress, leafy spurge, horsetail, cattail, honeysuckle, locust, ash and sumac. **Uptake and Translocation**: Absorbed by foliage and roots. Translocates well in xylem and phloem. Accumulates in growing regions of plant. **Basis of Selectivity**: Resistant plants metabolize amitrole more rapidly than sensitive plants and may have lower uptake as a result of leaf structure that reduces wetting and penetration. **Application Methods**: Foliar postemergence application to actively growing plants. Good coverage is essential. If weeds are mature, it is advisable to cut them and then spray the regrowth. Do not disturb treated plants for at least 2 weeks after application. Do not make postharvest application after Oct. 1. For control of quack grass and Canada thistle, apply in spring or fall to actively growing plants 15–20 cm tall: wait 10–14 days and then plough or disk. **Residual Activity**: Approximately 2–4 weeks in moist, warm soil. **Unique Characteristics**: Most crops are sensitive if contacted. Poor results may occur if spray coverage is inadequate, if plants are drought stressed or overmature, or if heavy rains fall within 6 hr after application. Do not graze or plant to grain, peas, alfalfa or clover for 8 months after treatment. Do not graze spot-treated areas in pastures for 6 months following treatment.

BENTAZON

Trade Names: BASAGRAN FORTE, BASAGRAN. **Chemical Family**: Benzothiadiazine. **Crop and/or Non-Crop Registrations**: BASAGRAN FORTE AND BASAGRAN: Peas, flax, soybeans, dry beans, faba beans, corn. BASAGRAN also registered for peanuts, lima beans, snap beans, highbush blueberry, new plantings of apples, apricots, cherries, peaches, pears and turf. **Sensitive Weeds**: Annual broadleaf weeds including hairy nightshade, lamb's-quarters, redroot pigweed, low cudweed, purslane, common ragweed, wild radish, Russian thistle, hairy galinsoga, corn spurry, bird rape, flower-of-an-hour, buttercups, common groundsel, jimsonweed, giant ragweed, velvetleaf, lady's-thumb, wild mustard, cocklebur, stinkweed, shepherd's-purse and common chickweed. Triazine-tolerant biotypes of lamb's-quarters, redroot pigweed, common ragweed and common groundsel are also controlled. Top growth of Canada thistle and nut sedge are controlled. Field bindweed may be suppressed by 2 applications applied 10 days apart. **Uptake and Translocation**: Taken up through the foliage. Not translocated. **Basis of Selectivity**: Metabolism by tolerant species. **Application Methods**: Postemergence when weeds are small and actively growing. Apply in 100–400 L water/ha. Crop must be in a tolerant growth stage (see specific recommendations on label). Thorough spray coverage is necessary. Use flat fan nozzles tilted 45° forward. Use ASSIST OIL CONCENTRATE with BASAGRAN. The ASSIST rate should be reduced under hot, humid conditions. CITOWETT PLUS may replace ASSIST on peas. Liquid ammonium sulphate or 28% urea ammonium nitrate may be added to BASAGRAN FORTE or BASAGRAN for improved and more consistent control of velvetleaf and lamb's-quarters in soybeans only. PINNACLE may be tank mixed with BASAGRAN FORTE or BASAGRAN for improved pigweed and lamb's-quarters control in soybeans only. BASAGRAN FORTE does not require additional adjuvants. BASAGRAN FORTE is not registered for aerial application. BASAGRAN is registered for aircraft application for soybeans, dry and snap beans. **Residual Activity**: Essentially none. **Unique Characteristics**: Corn and turf are tolerant at all stages of growth. Bentazon is not volatile. Temporary crop injury can be expected if bentazon is applied during hot, humid weather or if crop is stressed (flooding, drought, cold). Cool weather or drought may delay control. Rainfall within 6–8 hr after application may reduce effectiveness. Since there is no residual activity, a new flush of weeds may emerge after the first flush has been controlled.

CLOPYRALID

Trade Names: LONTREL 360, TRANSLINE. **Chemical Family**: Pyridine. **Crop and/or Non-Crop Registrations**: Strawberries, highbush blueberries, new and bearing apples, cranberries, sugar beets, rutabagas, cole crops (cabbage, cauliflower, broccoli, Asian cole crops), canola, barley, oats, wheat, control of broadleaf weeds in rights-of-way (hydro, railroad, communication lines, pipelines) and associated stations, industrial manufacturing sites, storage sites and roadsides, airports, military bases and low maintenance, rough-turf areas, rangeland, grass pasture and balsam fir Christmas tree stands or plantations. **Sensitive Weeds**: Will control or suppress certain annual and perennial weeds including Canada thistle, goldenrod, ox-eye daisy, tufted vetch, sheep sorrel, dandelion and wild buckwheat, scentless chamomile, groundsel, ragweed, coltsfoot and spotted knapweed. **Uptake and Translocation**: Rapidly absorbed by foliage and translocated readily throughout the plant via both xylem and phloem systems. Clopyralid is distributed throughout the plant to the meristem. **Basis of Selectivity**: Effects on nucleic acid metabolism and growth are not observed in grasses and other tolerant species. **Application Methods**: Postemergence as a broadcast or selective foliar. **Residual Activity:** Half-life in soil is less than 30 days under conditions that are favourable for microbial degradation. Little to no residual activity. **Unique Characteristics**: Clopyralid has little to no activity on woody vegetation, except woody species of the legume family.

COPPER ETHANOLAMINE

Trade Name: CUTRINE-PLUS. **Chemical Family**: Mixture of chelates of copper ethanolamines. **Crop and/or Non-Crop Registrations**: Algae control in wholly enclosed farm, fish and fire ponds and fish hatcheries having no outflow beyond the property limits of the user. **Sensitive Weeds**: Microcystis, Oscillatoria, Anabaena, Aphanizomenon, Spirogyra, Cladophora, Vaucheria, Ulothrix, Chara and Nitella. **Uptake and Translocation:** No information available. **Basis of Selectivity**: Non-selective. **Application Methods**: Available as a granular or liquid formulation. Apply early in the day, as ample sunlight is required for maximum control. To ensure even distribution of the granular formulation, employ a scoop or dry fertilizer spreader. Use a hand or power sprayer for best distribution of the liquid formulation. To avoid oxygen depletion, treat only $^1/_3$–½ of the pond at a time. Allow 1–2 weeks between treatments. **Residual Activity**: One application of granular CUTRINE-PLUS should provide control over the entire season. When using liquid CUTRINE-PLUS, a 2nd treatment later in the season may be required. **Unique Characteristics**: Not for use in potable waters. Not for use in public waters or waters that drain into public waters. Extremely toxic to fish in soft waters; toxic in hard waters if the maximum recommended concentration is exceeded; if fish are present but water hardness is not known, do not use CUTRINE-PLUS. Treated areas may be used for swimming or fishing immediately after treatment. Water from treated pools may be used to irrigate turf, fairways, putting greens and ornamental plants.

DICHLOBENIL

Trade Name: CASORON. **Chemical Family**: Benzonitrile. **Crop and/or Non-Crop Registrations:** Cranberries, fruit trees, grapes, highbush blueberries, raspberries, container nursery stock, woody nursery stock, shelterbelts and non-crop areas. **Sensitive Weeds**: Most weeds are susceptible to or suppressed by, dichlobenil including perennials, vetch and horsetail. **Uptake and Translocation**: Absorbed by the roots and rapidly translocated upward in the plant. **Basis of Selectivity**: Selectivity is based on physical separation between the dichlobenil vapour layer in the top 5 cm of soil and the established crop roots below this level. **Application Methods**: Applied preemergence to the weeds, preferably in either fall or early spring. **Residual Activity**: May persist and provide weed control for 2–6 months; higher rates and applications following use in previous year(s) may result in soil residues persisting for longer than 1 yr. **Unique Characteristics**: Although applied as a granular herbicide it kills by means of a vapour phase in the top soil profile. Weed roots take up the herbicide as they enter this zone. Do not apply dichlobenil during periods of high soil temperature, since loss of control will result due to volatilization of the herbicide.

DIQUAT (AQUATIC)

Trade Name: REWARD. **Chemical Family**: Bipyridylium. **Crop and/or Non-Crop Registrations**: Aquatic weed control in still or flowing water in ponds, ditches, lakes and canals. **Sensitive Weeds**: Coontail, Canada water weed, pondweeds, milfoil and duckweed. **Uptake and Translocation**: Contact desiccant with limited translocation. **Basis of Selectivity**: None. **Application Methods**: Postemergence. Apply when weeds are visible and are actively growing. It can be applied: with a boat bailer device that injects the chemical below the water surface; sprayed over the water surface; or poured directly from a container onto the surface. **Residual Activity**: Quickly inactivated by adsorption to soil particles. **Unique Characteristics**: Must be used with and applied on non-turbid water, as the soil particles in muddy water drastically reduce the effectiveness of the material. Apply at dusk. Do not use treated water for swimming or consumption by humans or animals for at least 24 hr. Do not use water for irrigation for 5 days after treatment. To avoid fish kills caused by oxygen depletion, treat only $^1/_4$–$^1/_3$ of the area at a time. Avoid application or drift onto crops, lawns, grazing areas, ornamental plants and other desirable plants.

DIURON

Trade Name: KARMEX. **Chemical Family**: Substituted urea. **Crop and/or Non-Crop Registrations**: Grapes, asparagus, gladioli, industrial sites, right-of-ways. **Sensitive Weeds**: Annual and perennial grasses, pigweed, ragweed, wild carrot and dandelion. Perennial weed control at higher rates in non-crop areas. **Uptake and Translocation**: Most readily absorbed by roots, less so by foliage. Translocated upward in the xylem. **Basis of Selectivity**: Used only in deep-rooted crops that are well established. **Application Methods**: Applied to crops as a preemergence or directed early postemergence spray, preferably before weed growth becomes dense. Better control of emerged weeds is obtained by the addition of a suitable surfactant. In non-crop areas, diuron may be sprayed anytime except when ground is frozen. **Residual Activity**: At lower rates used in crops, residues last about a year and thus applications may be repeated annually. At higher non-crop rates, persistence may be more than 1 yr. **Unique Characteristics**: Should not be used where it is likely to leach or wash into contact with the roots of desirable trees or shrubs.

FLUAZIFOP-P-BUTYL

Trade Names: FUSILADE II, VENTURE. **Chemical Family**: Aryloxyphenoxypropionate. **Crop and/or Non-Crop Registrations**: Flax, canola, soybeans, sugar beets, sunflowers, tobacco, forage legumes (alfalfa, red clover and bird's-foot trefoil), cabbage, broccoli, brussel sprouts, cauliflower, cucumber, onions, potatoes, rutabagas, tomatoes, highbush blueberries, raspberries, strawberries, non-grassy ornamental plants, poplars, shrubs, trees, apples, apricots, cherries, cranberries, peaches, pears and plums, forest and ornamental nurseries. **Sensitive Weeds**: Annual grass species, volunteer corn, wheat, barley and quack grass. **Uptake and Translocation**: Absorbed primarily by leaves. Translocated to roots and rhizomes. **Basis of Selectivity**: Metabolism by tolerant species. **Application Methods**: Postemergence. Apply when grasses are actively growing, and annual grasses are in the 2- to 5-leaf stage and quack grass is in the 3- to 5-leaf stage. **Residual Activity**: Essentially none. **Unique Characteristics**: Preplant tillage to break up rhizomes will improve control of quack grass. Except as noted on the label, broadleaf herbicides should be applied separately at least 3 days after fluazifop-p-butyl. Do not cultivate for 5 days after applying fluazifop-p-butyl. When plants are stressed (lack of moisture, excessive humidity, low temperature and/or very low relative humidity), fluazifop-p-butyl is less effective. Regrowth by tillering may occur if application is made under any of the above conditions. Since there is no residual activity, a new flush of weeds may emerge after the first flush has been controlled.

FUMIGANTS

(See metam sodium, methyl-bromide/chloropicrin)

GLUFOSINATE AMMONIUM

Trade Name: IGNITE, LIBERTY 200SN. **Chemical Family**: Unique. **Crop and/or Non-Crop Registrations**: IGNITE –Desiccation of dry beans and potatoes; directed applications in apples, grapes, peaches, pears and plums; stale seedbed techniques in asparagus, carrots, lettuce and onions; ground crack application in potatoes. LIBERTY 200SN–Corn hybrids and canola varieties specially developed to be tolerant to Liberty 200SN herbicide. Glufosinate-ammonium tolerant inbred lines grown for seed corn production. **Sensitive Weeds**: Non-selective–affects all actively growing green plants; regrowth of perennial species may occur. **Uptake and Translocation**: absorbed through foliage; minimal translocation-dependent on application rate and species treated. **Basis of Selectivity**: IGNITE–All green plant tissue is sensitive; safe on mature (non-green) bark of woody plants. LIBERTY 200SN–All green plant tissue is sensitive except for field corn, seed corn and canola plants that have been specially developed to be tolerant. **Application Methods**: IGNITE–Postemergence; broadcast or directed spray to avoid contact with leaves or green bark of desirable plants; thorough coverage of the plant tissue to be controlled is essential. LIBERTY 200SN–Postemergence. Can be broadcast in corn at the 1–8 leaf stage, apply with drop nozzles to later corn growth stages; cotyledon to early bolting stage in canola. **Residual Activity**: None; there are no cropping or rotational restrictions after application. **Unique Characteristics**: Speed of action is influenced by environmental factors; at cool temperatures, poor moisture and low humidity, speed of action may be reduced. Heavy dew at time of application may reduce control of certain weed species.

GLYPHOSATE TMS

Trade Name: TOUCHDOWN 480. See Glyphosate.

GLYPHOSATE

Trade Names: CREDIT, CLEAR-IT 1, CLEAR-IT 2, CLEAR-IT 3, EXPEDITE GRASS & WEED, E-Z-JECT, GLYFOS, LAREDO, MAVERICK, RENEGADE, ROUNDUP, ROUNDUP DRY, ROUNDUP L & G, ROUNDUP TRANSORB, TOUCHDOWN 480, TOUCHDOWN 600, VANTAGE, VANTAGE PLUS, VISION, WRANGLER. **Chemical Family**: Amino acid. **Crop and/or Non-Crop Registrations**: CREDIT, GLYFOS, LAREDO, RENEGADE, ROUNDUP, ROUNDUP TRANSORB, VANTAGE, VANTAGE PLUS, WRANGLER–preplant or postharvest with no cropping restrictions. Preharvest in wheat, barley, soybeans, canola, flax, lentils, peas and forages. TOUCHDOWN 480 for preharvest use in canola, barley, field beans, field peas, soybeans and wheat. ROUNDUP, ROUNDUP TRANSORB, VANTAGE, AND VANTAGE PLUS for in-crop uses in Roundup Ready crops. Directed applications in ginseng, cherries, grapes, apples, pears, plums and peaches, strawberries as wiper or spot treatment. **Non-Crop Registrations**: EXPEDITE GRASS & WEED, ROUNDUP–brush control; turf renovation; chemical mowing; directed application in woody nursery stock, roadsides and shelterbelts. ROUNDUP-asparagus. E-Z-JECT–selective woody brush and tree control. VISION–silvicultural site preparation, conifer release, forest tree plantings, forest tree nurseries. **Sensitive Weeds**: Annual grasses; perennial weeds (quack grass, Canada thistle, sow-thistle, field bindweed, milkweed, cattails, nut sedge, poison-ivy etc.); brush (birch, alder, poplar, raspberry, willow and maple). **Uptake and Translocation**: Absorbed through foliage and translocated throughout the plant. **Basis of Selectivity**: Non-selective for agricultural crops. Conifers are tolerant at some stages but the basis has not been established. **Application Methods**: Postemergence, usually at the bud to bloom stage of growth for most perennial weeds. Canada thistle should be at least in early flower bud, milkweed at flower bud, and bindweed at full flower. Quack grass can be treated in the spring or fall when it is actively growing with at least 3–4 new leaves on each emerged shoot; in the fall, remove crop refuse but do not till prior to application; fall or spring tillage prior to spring application may reduce control; wait at least 3–5 days after application before working the area; for maximum control it is advisable to till before the quack grass turns completely brown. Glyphosate can be applied with boom equipment, knapsack sprayers and high-volume equipment for agricultural and non-crop uses. Backpack mist blowers may be used for silvicultural site preparation and roadside brush control only. Aerial applications may be used for silvicultural site preparation and conifer release only. Can also be applied with selective equipment for non-crop areas, tree plantings, grapes and orchards. (See *Special Methods Of Weed Control* on page 205 and *Wick Wiper and Roller Application* on page 207) Regardless of method of application, do not allow herbicide solution to contact green foliage or green bark of crop or other desirable plants; remove all suckers from the trunks of desirable trees before spraying. **Residual Activity**: None: crops can be planted or seeded directly into treated areas following application. Other herbicides are required to control weeds emerging after the application. **Unique Characteristics**: Rainfall within 6 hr after application or heavy frost within 24 hr may reduce control. ROUNDUP TRANSORB is rainfast as soon as 4 hr after application.

GLYPHOSATE/GLUFOSINATE AMMONIUM

Trade Name: ROUNDUP FASTFORWARD PRESEED, ROUNDUP FASTFORWARD PREHARVEST. **Chemical Family**: Amino acid/Unique. **Crop and/or Non-Crop Registrations**: ROUNDUP FASTFORWARD PRESEED–Preplant treatments with no cropping restrictions. ROUNDUP FASTFORWARD PREHARVEST–Preharvest treatments in wheat, drybeans, canola, flax, peas, and lentils. **Sensitive Weeds**: Annual grass and broadleaf weeds and many perennials such as quack grass and Canada thistle. **Translocation**: Absorbed through foliage and translocated throughout the plant. **Basis of Selectivity**: Non-selective for agricultural crops. **Application Methods**: Postemergence to actively growing weeds using boom equipment (see glyphosate note for more information). **Residual Activ-**

ity: None. Crops can be planted directly into the treated areas following application. **Unique Characteristics**: Glyphosate/glufosinate ammonium provides quicker burndown of green vegetation than glyphosate alone. Rainfall within 2 hr after application or a heavy frost within 24 hr may reduce control.

LINURON

Trade Name: AFOLAN F, LINURON 480, LOROX DF, LOROX L. **Chemical Family**: Substituted urea. **Crop and/or Non-Crop Registrations**: Corn, soybeans, carrots, celery, dill, parsnips, potatoes, asparagus, wheat, oats, barley, gladioli, fruit trees. **Sensitive Weeds**: Annual weeds such as barnyard grass, common chickweed, corn spurry, crab grass, velvetleaf, fall panicum, foxtail, goosefoot, goose grass, groundsel, knotweed, lamb's-quarters, redroot pigweed, purslane, common ragweed, shepherd's-purse, smartweed, stinkweed, wild buckwheat, witch grass, wormseed mustard, triazine-resistant weeds; seedlings only of dandelion, plantain and sow-thistle. **Uptake and Translocation**: Readily absorbed through roots, less so through foliage; translocation primarily upwards in xylem. **Basis of Selectivity**: Differential metabolism often coupled with differential uptake and translocation. **Application Methods**: Preemergence, postemergence, directed postemergence, pre plus postemergence. **Residual Activity**: Does not pose a problem for subsequent crops since phytotoxic residues from applications at agricultural rates disappear within 4 months. **Unique Characteristics**: Do not use on sandy or coarse-textured soils having less than 2% organic matter. If unusually heavy rains follow application, severe injury may occur to corn, soybeans, carrots and potatoes.

MCPB/MCPA

Trade Name: CLOVITOX PLUS, TROPOTOX PLUS. **Chemical Family**: Phenoxy/phenoxy. **Crop and/or Non-Crop Registrations**: Seedling white, ladino, alsike or red clovers direct seeded or underseeded in wheat, oats, barley, rye, pastures, field corn, peas, grapes. **Sensitive Weeds**: Small emerged mustards, stinkweed, ragweed, lamb's-quarters, redroot pigweed, shepherd's-purse, volunteer rapeseed, wild radish, hemp-nettle, annual sow-thistle; top-growth control of bull thistle, Canada thistle, curled dock, plantain, perennial sow-thistle, field bindweed, horsetail, buttercup. **Uptake and Translocation**: Absorbed through the foliage and readily translocated, especially to the growing points. **Basis of Selectivity**: MCPB is not directly toxic to plants. Susceptible weeds convert MCPB to MCPA. **Application Methods**: Postemergence. In cereals, clovers and peas, apply as an overall spray. In corn, apply with drop pipes after the corn reaches 45 cm before the beginning of tasselling. Apply to pastures after grazing or cutting.

METAM SODIUM

Trade Name: VAPAM. **Chemical Family**: Thiocarbamate. **Crop and/or Non-Crop Registrations**: Field and greenhouse seedbeds. Field-replant sites of fruits, vegetables, tobacco, ornamentals and forest-tree stock. **Sensitive Weeds**: Most scarified weed seeds and freshly vegetative parts including rhizomes and germinating seedlings. **Basis of Selectivity**: Most plant parts are sensitive. Crops are not planted until all fumigant has dissipated from the soil. With moisture, methyl isothiocyanate gas is released, which kills most scarified seeds and fleshy vegetative parts including rhizomes and germinating seedlings. **Application Methods**: Apply uniformly using injectors, water or other incorporation tools to carry the product to the desired soil depth. May be applied via the irrigation system. No gas-proof cover is required unless the soil is very porous, however, a sprinkler application of water should be used to provide a surface "water seal". **Residual Activity**: 10–40 days depending on soil temperature and the amount of organic matter present in the soil. Persistence is greatest at low temperatures and high levels of organic matter. Planting may take place 12–16 days after the treatment and following a lettuce-seedling bioassay that indicates no injury. **Unique Characteristics:** Also controls nematodes, soil fungi and soil insects. All traces of toxic gases must be dissipated from the treated soil before planting or plant injury may occur.

METHYL BROMIDE/CHLOROPICRIN

Trade Name: TERR-O-GAS 67. **Chemical Family**: Organohalogen. **Crop and/or Non-Crop Registrations**: Greenhouse and tobacco seedbeds. Methyl bromide is very poisonous to humans and livestock; only an experienced operator should attempt its use. **Sensitive Weeds**: Gas is toxic to germinating seedlings. **Application Methods**: Formulated as a liquid under pressure, that, when released from the container, forms a gas. Soil must be sealed with a plastic sheet since the gas is highly volatile. Refer to label for detailed directions. **Unique Characteristics**: Methyl bromide gas is highly volatile and highly poisonous to humans and livestock. It may be absorbed by inhalation, ingestion and skin contact. A permit must be obtained from the Ontario Ministry of the Environment each time it is used. Also controls soil insects, nematodes and fungal diseases.

METOLACHLOR

See S-METOLACHLOR

METRIBUZIN

Trade Names: CONQUEST A (Available only in CONQUEST co-pack), EVICT SOLUPAK, LEXONE DF, SENCOR 500 F, SENCOR 75 DF, SENCOR SOLUPAK. **Chemical Family**: S-triazine. **Crop and/or Non-Crop Registrations**: Established asparagus, faba beans, potatoes, soybeans, transplant tomatoes, apples, apricots, peaches, cherries, corn and triazine-tolerant canola with trifluralin or with terbacil or with metolachlor on apples, apricots, cherries, plums, peaches and pears. **Sensitive Weeds**: Lamb's-quarters, wild mustard, redroot pigweed, common ragweed, shepherd's-purse, lady's-thumb, velvetleaf, jimsonweed, prostrate pigweed, Russian thistle, yellow woodsorrel, prickly mallow, chickweed, cocklebur, carpetweed, dandelion seedlings, barnyard grass, crab grass, foxtail, fall panicum, witch grass, Johnson grass seedlings and cheat grass. **Uptake and Translocation**: Some uptake through the foliage but the major route is via the roots. Translocation upwards in the xylem. **Basis of Selectivity**: Degradation by tolerant species. **Application Methods**: Preplant incorporated (potatoes, soybeans, apples, apricots, peaches, cherries, corn, tomatoes and triazine-tolerant canola); preemergence (asparagus, potatoes, soybeans and triazine-tolerant canola); postemergence (potatoes, tomatoes, corn and triazine-tolerant canola). **Residual Activity**: Varies with the climate. At normal-use rates the half-life is 1–2 months. **Unique Characteristics**: Heavy rainfall following application may cause crop damage. Some varieties of potato, soybean and tomato are less tolerant than others. Triazine-resistant weeds are not controlled. Do not use on muck soils.

NAPROPAMIDE

Trade Names: DEVRINOL 50 DF, DEVRINOL 50W, DEVRINOL 10G. **Chemical Family**: Amide. **Crop and/or Non-Crop Registrations**: Asparagus, cole crops (cabbage, broccoli, cauliflower, Chinese broccoli, Chinese mustard greens, Chinese Nappa cabbage, Chinese radish), garlic, kohlrabi, peppers, pumpkin, squash, fuzzy squash, rutabagas, tomatoes, tobacco, raspberries, blackberries, cultivated lowbush blueberries, established highbush blueberries, boysenberries, cranberries, loganberries, newly planted or established strawberries, apples, grapes, peaches and pears, newly transplanted or established ornamentals, woody nursery stock, forest tree stock and container-grown ornamentals (see label for species). With simazine or with terbacil on new plantings of apples, apricots, cherries, plums, peaches and pears. **Sensitive Weeds**: Many annual weeds including crab grass, barnyard grass, annual bluegrass, foxtails, sandbur, wild oats, goose grass, chickweed, groundsel, redroot pigweed, lamb's-quarters, purslane, prostrate knotweed, pineappleweed and prickly lettuce. **Uptake and Translocation**: Absorbed through the roots of germinating weeds. Translocated upward through seedling. **Basis of Selectivity**: Metabolized by tolerant species. Root growth of germinating seedlings is inhibited. Established plants are not affected due to placement selectivity. **Application Methods**: May be applied preplant incorporated using water as the carrier. Incorporation should be uniform, and to a chemical depth of 2.5–5 cm, using irrigation or proper incorporation equipment (e.g., tandem discs or field cultivator with sweep teeth) followed by a levelling device. On established crops, apply to a weed-free soil surface and irrigate in if no rainfall occurs within 7 days after application in spring or fall, or within 2 days after application in summer; irrigate with sufficient water to wet the soil to a depth of 5–10 cm (approximately 7 mm of rain). For postplant application in tobacco, apply in 25 cm band over the row. Cross-disc or cross-plough after harvest to dilute soil residue before planting cover crop. **Residual Activity**: Provides season-long weed control if properly incorporated. Deep ploughing will minimize any carryover effect. **Unique Characteristics**: Will not control germinated weeds. Resists leaching. To avoid injury to crops not registered for use with napropamide, do not plant until 12 months after the last napropamide application.

PARAQUAT

Trade Name: GRAMOXONE. **Chemical Family**: Bipyridylium. **Crop and/or Non-Crop Registrations**: Apples, apricots, cherries, currants, gooseberries, grapes, highbush blueberries, peaches, pears and plums established more than 1 yr; blackberries, loganberries and red raspberries; inter-row spraying in strawberries; stale seedbed technique for vegetables and field crops; inter-row directed chemical weeding for vegetable fields and established nursery crops; asparagus; potatoes; established alfalfa and bird's-foot trefoil; pasture renovation; zero tillage corn; conifer control; turf renovation; chemical mowing weed control in non-crop land; aquatic weed control. **Sensitive Weeds**: Non-selective–affects all green plants. **Uptake and Translocation**: Absorbed by foliage and green bark; little or no translocation. **Basis of Selectivity**: All green plant tissue is sensitive. Less effective on plants with a very waxy cuticle and linear leaf shape such as nut sedge. Safe on mature (non-green) bark of woody plants. **Application Methods**: Postemergence. Broadcast, or directed spray to avoid contacting leaves or bark of desirable plants. Apply when weeds are less than 15 cm high. Better results are usually obtained if application is made on a dull or cloudy day, or in the evening. **Residual Activity**: Essentially no residual activity in soil. Will persist in organic material such as mulches or turf thatch; therefore, do not reseed these areas for 5 days. More than 1 application/season may be necessary, especially for perennial weeds. **Unique Characteristics**: Inactivated by adsorption to soil particles. Not available to homeowners. For a domestic registration, see paraquat/diquat.

PROPYZAMIDE

Trade Name: KERB. **Chemical Family**: Amide. **Crop and/or Non-Crop Registrations**: Alfalfa, bird's-foot trefoil, woody nursery stock, lettuce, apples, pears, lowbush blueberries. **Sensitive Weeds**: Perennial grasses including quack grass, annual grasses, volunteer cereals and common chickweed. **Uptake and Translocation**: Taken up by plant roots and translocated to the foliage. Little foliar absorption. **Basis of Selectivity**: Faster degradation in tolerant species. **Application Methods**: Preemergence to annual weeds. Postemergence control of perennial grasses when applied in the fall. Apply in the fall from late Sept. to early Nov. when the soil temperature is low but above freezing, and soil moisture is high. **Residual Activity**: Persistence is variable (2–9 months), depending on soil type and climatic conditions. Decomposition of the herbicide is slow at temperatures below 15°C but accelerates at temperatures above this level. Persistence is greatest in sandy soils with low organic matter. **Unique Characteristics**: Rainfall or irrigation is required after application to move the herbicide into the root zone for uptake by perennial grasses and germinating annual grasses.

S-METOLACHLOR

Trade Names: DUAL MAGNUM, DUAL II MAGNUM. **Chemical Family**: Acetanilide. **Crop and/or Non-Crop Registrations**: Corn, soybeans, snap beans (yellow and green only), dry beans (white, kidney and pinto only), lima beans, transplanted cole crops (cabbage, cauliflower, broccoli), transplanted tomatoes, potatoes, sugar beets, processing peas, rutabagas and sweet white lupins, apples, apricots, cherries, peaches, pears and plums. **Sensitive Weeds**: Large and smooth crab grass; witch grass; barnyard grass; fall panicum; giant, green and yellow foxtail; yellow nut sedge; American nightshade, eastern black nightshade. **Uptake and Translocation**: Absorbed by germinating grasses mainly through shoot just above seed. Absorbed by germinating broadleaf weeds through roots and shoots. **Basis of Selectivity**: Metabolized by tolerant species. **Application Methods**: Early preplant, preplant incorporated and preemergence. Early postemergence on corn (spike to 2–leaf stage of corn). Incorporation equipment should be set to work the soil 10 cm deep with a disc operating at 6–10 km/hr or a vibrating shank cultivator at 10–13 km/hr; 1 incorporation is sufficient and need not be immediate. Rainfall within 10 days is required for maximum activity of the preemergence application. **Residual Activity**: Activity will normally be maintained for 10–14 weeks. **Unique Characteristics**: The rate required depends on weed pressure (higher rate for heavier weed pressure). Yellow nut sedge control requires a preplant incorporated application. Winter cereals may be planted 4–5 months after metolachlor application. Many tank mix combinations are registered on various crops. Do not use on muck soils or coarse-textured soils low in organic matter. DUAL II MAGNUM contains benoxacor, a chemical that enhances the corn plant's ability to metabolize s-metolachlor, thereby preventing corn injury even under adverse environmental conditions.

SETHOXYDIM

Trade Name: POAST ULTRA. **Chemical Family**: Cyclohexanedione. **Crop and/or Non-Crop Registrations**: Canola (rapeseed), flax, soybeans, dry beans, snap beans, peas, onions, tomatoes, potatoes, sweet potato, pumpkin, squash, cucumbers, alfalfa, lima beans, faba beans, adzuki beans, mung beans, buckwheat, creeping red fescue, garlic, broccoli, cabbage, cauliflower, peppermint, spearmint, apples, apricots, cherries, peaches, pears, plums, highbush blueberries, cranberries, strawberries and sethoxydim-resistant corn. **Sensitive Weeds**: Annual grasses (wild oats, foxtails, barnyard grass, large crab grass, proso millet, fall panicum and witch grass), volunteer corn and cereals and quack grass. **Uptake and Translocation**: Absorbed by foliage. Translocated upwards and downwards in plant. **Basis of Selectivity**: Degraded by tolerant species (broadleaf plants). **Application Methods**: Postemergence to actively growing annual grasses in the 1- to 6–leaf stage and quack grass in the 1- to 3–leaf stage. Use flat fan nozzles and add MERGE adjuvant to the spray mix. Alternatively, ASSIST OIL CONCENTRATE or Ammonium sulphate plus ASSIST OIL CON-

CENTRATE may be used. Other postemergence herbicides that are not recommended as tank mix combinations on the label must be applied at least 4 days before or after sethoxydim application. Aerial application is also registered. **Residual Activity**: Essentially none. A 2nd application and/or cultivation may be necessary to control grasses that emerge after treatment. **Unique Characteristics**: Susceptible grasses, when sprayed, stop growing immediately and then gradually turn yellow to purple to brown over a period of 7–21 days, depending on growing conditions and crop competition. Rainfall within 1 hr after application may reduce effectiveness. If treated grasses are stressed (drought, flooding, prolonged cool temperatures) control will be delayed or reduced.

SIMAZINE

Trade Names: PRINCEP NINE-T, SIMADEX, SIMAZINE, SIMAZINE 480. **Chemical Family**: S-triazine. **Crop and/or Non-Crop Registrations**: Corn, established asparagus, bird's-foot trefoil, raspberries, loganberries, blackberries, highbush blueberries, alfalfa, apples, apricots, cherries, peaches, pears and plums established for 1 yr or more; grapes established for 3 or more yr; shelterbelts established for at least 1 growing season (caragana, green ash, Siberian elm, American elm and Manitoba maple); new or established Christmas tree and woodland plantations (2 yr or older white pine and balsam fir); woody ornamentals and nursery stock established for at least 1 yr (cedar, barberry, apple, flowering crab apple, box wood, cotoneaster, dogwood, holly, rose, yews, chamaecyparis, hemlock, juniper, multiflora rose, peony; spruce, mugho pine, black walnut and white ash); nursery container stock (cedar, juniper, yew); aquatic weed control; non-crop land. Conifer site preparation before planting of fir, pine and spruce (Princep Nine-T only). **Sensitive Weeds**: Annual broadleaf weeds such as pigweed, lady's-thumb, lamb's-quarters, purslane, ragweed, volunteer clover, wild buckwheat, smartweed, plantain and groundsel; annual grasses such as barnyard grass, crab grass, wild oats and yellow foxtail (triazine-resistant biotypes of foxtail, lamb's-quarters, pigweed and groundsel will not be controlled); most perennial species starting freshly from seed. **Uptake and Translocation**: Absorbed by roots; little or no foliar absorption; translocated upwards in xylem, accumulating in apical meristem and leaves with napropamide on new plantings of apples, apricot, cherries, plums, peaches and pears. **Basis of Selectivity**: Some species, such as corn, metabolize simazine. In most crops, selectivity is based on the roots of the crop plants being deeper than the depth to which simazine leaches. **Application Methods**: Preplant incorporated (to a depth of 2.5 cm) or preemergence in corn; preemergence in other crops. Broadcast or band application. In fruit crops, apply a 1m wide band under the plants; cultivate or sod the area between the rows. For aquatic weed control, apply as a draw-down treatment or water-volume application in drainage ditches and ponds with no water flow-through. **Residual Activity**: Soil residues may persist for more than 1 season. After spraying with simazine, do not plant any crop in the treated area in the same year except corn. Where rates in excess of 2 kg/ha have been applied, do not plant rotational crops in the following year; test soils if there is any question of excessive residues remaining. **Unique Characteristics**: Needs sufficient moisture to be activated. Apply only once/season. To avoid build-up of resistant weeds, rotate simazine with other non-triazine residual herbicides. Simazine is more persistent than atrazine. Where rainfall is sufficient to cause erosion, soil containing simazine may wash to lower areas of land and injure existing or subsequent crops.

SURFACTANT

See *Notes on Adjuvants* on page 199.

TERBACIL

Trade Name: SINBAR. **Chemical Family**: Uracil. **Crop and/or Non-Crop Registrations**: apples, apricots, cherries, highbush blueberries, peaches, pears, plums, spearmint, peppermint, and strawberries; with napropamide on new plantings of apples, apricots, cherries, plums, peaches and pears. **Sensitive Weeds**: Barnyard grass, bluegrass, crab grass, foxtail, chickweed, cheat grass, perennial rye grass, wild barley, mustard, prickly lettuce, stinkweed, annual sow-thistle, henbit, lamb's-quarters, pigweed, purslane and ragweed. Partial control of quack grass, horsenettle, vetch and yellow nut sedge. **Uptake and Translocation**: Uptake is mostly through roots, although partially through foliage and stem. Translocation is upward into leaves. **Basis of Selectivity**: Used only on established plantings so that roots of crop are below depth to which chemical penetrates. May also be slower translocation and faster degradation in tolerant species. **Application Methods**: Apply to the soil surface in 200–1,000 L water/ha. If weed growth is present in apples, paraquat may be mixed with spray. Rates for strawberries are considerably lower and can be applied in spring, postharvest or late fall. Control of perennial grasses may be improved by cultivation prior to treatment. **Residual Activity**: May be up to 2 yr. Residues are likely to be higher on heavier soil types if higher rates and repeated applications are used. **Unique Characteristics**: Moisture is necessary to activate the chemical within 2 weeks after application. Do not apply on soils with less than 1% organic matter, nor on eroded soil areas. Use lower rates on soils with 1%–2% organic matter. Do not apply on weak or diseased strawberry plants.

TRIFLURALIN

Trade Names: BONANZA 400, RIVAL, TREFLAN EC. **Chemical Family**: Dinitroaniline. **Crop and/or Non-Crop Registrations**: Soybeans, dry beans (white or kidney), faba beans, snap beans, lima beans, black beans, canola (rapeseed), triazine-tolerant canola (variety of O.A.C. Triton, pedigreed seed only), sunflowers, turnips, peas (field and canning), direct-seeded alfalfa; transplants of tomatoes, peppers, Brussels sprouts, broccoli, cabbage and cauliflower; carrots, crambe, direct-seeded cabbage and cauliflower, annual flowers, woody ornamental plantings and field-grown nursery stock, perennials, established shelterbelts, strawberries. **Sensitive Weeds**: Effective on most annual grasses, and will provide good control of pigweed and lamb's-quarters, including the triazine-tolerant biotypes of these weeds. **Uptake and Translocation**: No significant absorption or translocation of trifluralin in crops grown in soil treated with trifluralin. Susceptible weeds are controlled as they germinate. Established weeds are not controlled. **Basis of Selectivity**: Physiological growth processes associated with seed germination. **Application Methods**: Preplant incorporated. Apply in 100–300 L of water/ha. Use lower rate of the chemical on sandy soils and increased rate for loam-to-clay soils. Do not use on highly organic soils (muck, peat or black sands above 15% organic matter). Incorporate twice in cross directions using a tandem disc (7–10 km/hr) or tine cultivator (10–13 km/hr) set to work 8–10 cm deep. The 1st incorporation should be done as soon as possible after application, but may be delayed 8–24 hr, depending on label directions. The 2nd incorporation is recommended anytime before planting. Activated upon incorporation; rainfall is not required. **Residual Activity**: Recommended application rates provide season-long weed control. Succeeding crops, even fall-seeded grain crops planted in soil that received trifluralin the preceding spring, will not be injured under normal conditions. **Unique Characteristics**: Strongly absorbed to soil particles and shows negligible leaching. Organic matter and clay content influence application rate. Does not control ragweed, annual nightshades or mustards; lady's-thumb may escape.

Notes on Adjuvants

Introduction

An adjuvant is any substance added to a spray solution to modify and enhance the effectiveness of the herbicide.

Adjuvants are an important part of the spray solution and, if omitted, weed control can be reduced. Some products have adjuvants formulated into the product while other adjuvants are added by the user. The selection of adjuvants is key to getting the right balance between maximizing weed control and minimizing crop injury. In some cases the rate of adjuvant will vary depending on conditions of weather, crop stage, weed species, water quality, etc. Some herbicide labels recommend particular adjuvant products and some recommend particular types of adjuvants. Always use adjuvants as directed on the product label.

Most adjuvant recommendations in this guide are listed as the amount (in litres) that would be added to 1,000 litres (L/1,000 L) of spray solution. If you wish to convert to % volume/volume (v/v) use the following conversion:

10 L/1,000 L = 1% v/v

There are 2 broad categories of adjuvants:

- Activators and spray modifiers
- Utility modifiers

Activators and Spray Modifiers

- **Surfactants** (also known as "surface active agents") are the **largest** class of adjuvants. Surfactants can be non-ionic, anionic, cationic or amphuteric. Most surfactants are non-ionic (NIS); they do not ionize. A NIS is used to enhance herbicide penetration into a waxy cuticle. Wetting agents and detergents are primarily anionic and when ionized in solution, the water soluble portion is negatively charged. Cationic surfactants exhibit a net positive charge in solution. Amphuteric surfactants can be either anionic or cationic. Cationic and amphuteric are not widely used in agricultural chemicals.

- **Oils** solubilize the waxy cuticle layer on a weed to increase spray penetration through the leaf cuticle. Oils can be refined mineral oils (petroleum based) or seed oils. Seed oils can be categorized as triglycerides, methylated seed oils (MSO) or crop oil concentrates (COC). Crop oil concentrates are a combination of seed oil and surfactants.

- **Spreaders** are wetting agents that reduce the surface tension to create better contact between the spray solution and the treated surface (leaf, etc.). A **sticker** increases the herbicide adhesion to the leaf surface.

Utility modifiers

- **Compatibility** agents improve mixing, especially when using a liquid fertilizer carrier.

- **Drift control** agents increase the droplet size to reduce drift.

- **Anti-foaming** agents are used to reduce foaming in the spray tank.

- **Foaming** agents are used with specialized equipment to produce and apply a foam.

- **Buffering** agents can be used enhance solubility or adjust pH.

Note

The following notes should be considered with the recommendations given later in this publication. Additional information on use, toxicity and safety precautions is given here. With a few exceptions the adjuvants are listed under their trade or product name. See Table 12–3, *Adjuvants Used in Ontario,* on page 204.

Complete information on each adjuvant is available on the product label which is located on the product container. The federal Pest Management Regulatory Agency also lists pesticide labels on their internet Web site at: http://64.26.129.82/search/queryhit.htm.

Many pesticide manufacturers also list product labels and/or Material Safety Data Sheets (MSDS) on their Web sites. See Table 13–4, *Pest Control Product Companies,* on page 280.

38-F DRIFT RETARDANT

Type of Adjuvant: Drift-control agent. **Chemical Composition**: Polyacrylamide polymer 32%. **Registered Uses**: For non-crop use with most water-soluble, emulsifiable or wettable-powder formulations of pesticides. **Benefit**: Drift control. **Mode of Action**: When tank mixed with a pesticide, 38-F reduces drift by materially reducing fines resulting from shear. **Mixing**: Add 38-F at a steady rate into the mixing tank at the point of maximum agitation. In most cases, this is where the liquid level in the tank is at or just below the injection point of the filling water. After the last tank addition has been made, allow the mixing to continue for a few minutes before using. Refer to product label for more information.

AGRAL 90

Type of Adjuvant: Non-ionic surfactant. **Chemical Composition:** Nonylphenoxy polyethyoxyethanol 90%. **Registered Uses:** For use with diquat, paraquat, glyphosate, imazethapyr, rimsulfuron, nicosulfuron/ rimsulfuron and for washing sprayer tanks and equipment. **Benefit:** Improves chemical effectiveness. **Mode of Action:** It is a wetting and spreading agent that improves coverage of spray mixes. **Mixing:** Use 250–1,000 mL/1,000 L of spray as specified on label. Will mix with all types of water. Add AGRAL 90 to the spray mixture and agitate thoroughly. **Unique Characteristics:** Do not exceed the recommended rates of AGRAL 90 as too much wetting agent can lead to loss of spray due to excessive run-off.

AG-SURF

Type of Adjuvant: Non-ionic surfactant. **Chemical Composition**: Nonylphenoxy polyethyoxyethanol 92%. **Registered Uses**: For use with glyphosate, imazethapyr and fluazifop-p-butyl. **Benefit:** Improves chemical effectiveness. **Mode of Action**: It is a wetting and spreading agent that improves coverage of spray mixtures. **Mixing**: For use with ROUNDUP: when applying the

2.5 L/ha of water, add AG-SURF at 0.5% (0.50 L/100L water) to maintain adequate surfactant concentration. For use with ROUNDUP to control annual grasses and broadleaf weeds for minimum or zero-till: use 350 mL/ha plus ROUNDUP at 1.1 L/ha in 50–100 L/ha of clean water. For use with FUSILADE 250EC: add 100 mL of AG-SURF for each 100 L of spray solution (0.1%). An antifoaming agent may be required to reduce foaming. **Unique Characteristics**: Do not exceed recommended rates of AG-SURF, as too much may reduce the effectiveness of the herbicide due to excessive run-off. Consult product label for full directions.

AQUASHADE

Chemical Family: Water-soluble dyes. **Crop and/or Non-Crop Registrations**: Contained golf course, farm and industrial ponds, fountains and aquariums. **Sensitive Weeds**: Filamentous algae and certain aquatic weeds. **Uptake and Translocation**: The dye filters wavelengths of sunlight reducing the light intensity. **Application Methods**: May be added in a concentrated form from the shoreline or diluted form for larger areas. It is recommended to make the application early in the growing season before algae and weed growth develops. Mechanical removal of heavy vegetation is recommended before applying Aquashade if fish are present in the pond. **Residual Activity**: The effect lasts as long as the water keeps its blue colour. Additional Aquashade can be applied when the colour of the water fades or when the first new algae and weed growth is noticed. **Unique Characteristics**: It has no direct chemical action and will therefore not harm fish.

ASSIST OIL CONCENTRATE

Type of Adjuvant: Mineral oil/surfactant (non-herbicidal). **Chemical Composition**: 83% paraffin base mineral oil plus 17% surfactant blend. **Registered Uses**: ASSIST OIL CONCENTRATE is registered for use with sethoxydim, BASAGRAN, bentazon/atrazine and atrazine. **Benefit**: The use of ASSIST results in improved postemergence activity and a greater degree of consistency under varying environmental conditions. ASSIST will also aid in providing a faster weed kill. **Mode of Action**: Reduces the evaporation of spray droplets on the leaf surface leading to a longer period for penetration. Improves penetration through the leaf cuticle layer. ASSIST also aids in spreading a spray droplet on the leaf surface so that it covers a greater surface area. **Mixing**: Half-fill the spray tank with water and begin agitation. Add the desired amount of herbicide and continue filling. Add ASSIST last. After filling, continue agitation. Agitate thoroughly after any stoppage in spraying. **Unique Characteristics**: May cause increased temporary topical burn to crop plants under hot, humid weather conditions.

BREAKER

Type of Adjuvant: Antifoamer/Defoamer. **Registered Uses**: To reduce foaming when preparing herbicide spray mixes. **Benefit**: Small quantities of BREAKER added before adding herbicides will prevent foam from forming. **Mixing**: Add 7 mL/500 L of spray mix. **Unique Characteristics**: Can be added after foam has formed but more time will be required to eliminate the foam.

CHOICE

Type of Adjuvant: Water conditioning agent. **Chemical Composition**: Blend of polyacrylic, hydroxy carboxylic, propionic acids, phosphate ester and ammonium sulfate. **Benefit**: Eliminates "hard water antagonism" and instability due to high pH. **Mode of Action**: Conditions water by sequestering or chelating hard water ions and by the reduction in pH.

COMPATABILITY AGENTS]

(e.g. UNITE)

ANTIFOAMERS/DEFOAMERS

(e.g. BREAKER, FIGHTER F, FLAT-OUT, HALT, SPRAY ADJUVANT DEFOAMER)

DRIFT-CONTROL AGENTS

(e.g. 38-F DRIFT RETARDANT, NALCO-TROL, ON TARGET.)

ENHANCE

Type of Adjuvant: Cationic surfactant with an additional non-ionic component. **Chemical Composition**: Mixture of tallow fatty acid amine ethoxylate and nonylphenoxy polyethoxy ethanol. **Registered Uses**: Season-long control of quack grass at low rate of glyphosate. For use with postemergent applications of imazethapyr in soybeans. **Benefit**: Improves consistency of performance, particularly at high water volumes and under stressful growing conditions. **Mode of Action**: Improves leaf wetting and adhesion; increases overall penetration, resulting in enhanced uptake of glyphosate. **Mixing**: Half-fill the sprayer tank with clean water then add the required amount of glyphosate. While agitating, add the required amount of

ENHANCE (0.5 L/ha in 100–200 L/ha of water) and complete filling the sprayer tank with water.

FIGHTER F

Type of Adjuvant: Antifoamer-Defoamer. **Chemical Composition**: Dimethyl-polysiloxane 10%. **Registered Uses**: To control foam in water, oil, fertilizer and pesticide spray mixtures. **Benefit**: Controls foam when mixing sprays, eliminates material waste, provides more accurate metering of agricultural sprays, and eliminates foam overflow at fill site. **Mixing**: To control foam when mixing spray solution, add defoamer either just before or during addition of any other spray adjuvant. To cut existing foam, add defoamer to tank and recirculate solution until foam dissipates.

FLAT-OUT

Type of Adjuvant: Defoamer. **Chemical Composition**: Dimethylpolysiloxane 18% Silicone base neutral. **Registered Uses**: To control foam formation or existing foam, use as premix or add while spray tank is being filled. **Benefit**: The reduction of foam allows for faster tank fill, ensures fill volumes are correct and reduces the possibility of chemical overflow, therefore more accurate application. It also makes the cleaning process easier. **Mixing**: Add 5–10 ml/100 L of solution. Adjust the amount required according to individual conditions. May be used before mixing to prevent foam, or after to cut foam. May be used with any herbicide unless contraindicated on the label.

FOAM MARKERS

(e.g. TREKKER TRAX)

HALT

Type of Adjuvant: Defoamer. **Chemical Composition**: Silicone base, neutral. **Registered Uses**: To reduce foaming when preparing herbicide spray mixes. **Benefit**: The reduction of foaming allows faster tank fill-ups, ensures correct fill volumes, reduces the possibility of chemical overflow and gives more accurate herbicide application. **Mixing**: Add 7 mL/500 L of spray mix. May be added to spray tank during filling to prevent foaming, or after to cut foam. **Unique Characteristics**: May be used with any herbicide unless contraindicated on the label.

HERBICIDAL OIL

(e.g. Notes on Herbicides MINERAL OIL [HERBICIDAL]

LI700

Type of Adjuvant: Non-ionic surfactant and pH Adjuster/Acidifier. **Chemical Composition**: Phosphatidylcholine, methylacetic acid and alkyl polyoxyethylene ether 80%. **Registered Uses**: As a penetrating surfactant; as a pH adjuster/acidifier; for use with glyphosate products such as ROUNDUP, LAREDO, RENEGADE, WRANGLER and VISION. Alkaline water, even mildly alkaline, causes alkaline hydrolysis or degradation of many pesticides. Some chemicals degrade in less time than it takes to put out a tank of spray. When mixed with spray solutions, LI700 neutralizes or slightly acidifies the spray solution and prevents the breakdown hydrolysis of pH-sensitive products in the spray tank. Add LI700 before adding the pesticide. **Benefit**: Improves chemical effectiveness. **Mixing**: As a penetrating surfactant: Use 5 L of LI700/1,000 L spray mixture or 500 ml of LI700/100 L spray mixture. As a pH adjuster/acidifier, highly alkaline water, (pH 8 or higher): Use: 625 mL–1.25L LI700/1,000 L water mixture.

MERGE

Type of Adjuvant: Surfactant/solvent. **Chemical Composition**: 50% surfactant blend plus 50% solvent (petroleum hydrocarbons). **Registered Uses**: For use with sethoxydim. **Benefit**: Improves chemical effectiveness and provides a greater degree of consistency under varying environmental conditions. **Mode of Action**: Improves spreading of spray droplets on the leaf surface and increases contact surface area. Improves penetration of herbicide through the leaf cuticle layer. Acts as a protectant against photodegradation of sethoxydim by UV light. **Mixing**: Half-fill spray tank with water, start agitation. Add required amount of herbicide and continue agitation. Add MERGE, along with remaining water, last to the tank. Agitate thoroughly after any stoppage in spraying. **Unique Characteristics**: May cause temporary topical burn to crop plants under hot, humid weather conditions.

MINERAL OIL/SURFACTANT (NON-HERBICIDAL)

(e.g. ASSIST OIL CONCENTRATE, CHARGE OIL CONCENTRATE, KORNOIL CONCENTRATE XA OIL CONCENTRATE)

NALCO-TROL

Type of Adjuvant: Drift-control agent. **Chemical Composition**: Polyvinyl polymer. **Registered Uses**: For use with 2,4-D ester or amine, picloram, paraquat, simazine or dicamba for weed or brush control in non-crop land. **Benefit**: Reduces drift, improves canopy penetration and foliage coverage. **Mode of Action**: Reduces spray break-up and thus the number of fine, driftable droplets. **Mixing**: Use 3–1,000 mL/1,000 L, depending on pressure, height and nozzle type. Add water and, while agitating, add NALCO-TROL before adding liquid herbicides. Add wettable-powder herbicides to water and ensure dispersion before adding NALCO-TROL. **Unique Characteristics**: Product is extremely slippery; take care when working on spray equipment and following a spill.

OIL

(e.g. MINERAL OIL)

ON TARGET

Type of Adjuvant: Deposition Aid / Drift Control agent. **Chemical Composition**: Polyvinyl Polymer (Polyacrylamide) 30%. **Registered Uses**: For use with most water soluble and wettable powder pesticides and desiccants, including Glyphosate, when applied by aerial application or standard ground equipment. **Benefit**: Deposition improvement and drift retardation in spraying operations, to potentially reduce injury to adjacent crops or plants. **Mode of Action**: When tank mixed with a pesticide ON TARGET reduces drift by materially reducing fines resulting from shear. **Mixing**: Fill mix tank with water, pesticide and other additives and begin to agitate. Select correct dosage, SHAKE BOTTLE WELL BEFORE USING, either inject ON TARGET liquid into the suction side of the feeder or recirculating pump or slowly add ON TARGET liquid to the rapidly agitating tank mix in the area of highest turbulence by pouring a very thin stream. This obtains the best dispersion of the polymer throughout the pesticide solution. Allow mixing to continue for at least 2 minutes before spraying.

SURFACTANTS

(e.g. AGRAL 90, AG-SURF, COMPANION, CAN-PLUS 411,CITOWETT PLUS, ENHANCE, LI700, MERGE, SIDEKICK, SUPER SPREADER, SYLGARD 309, XA OIL CONCENTRATE)

TREKKER TRAX

Type of Adjuvant: Foam marker. **Chemical Composition**: 24% alcohols and 30% mixed anionic and nonionic surfactants. **Benefit**: Improves placement of herbicides by indicating area of field sprayed. **Mixing**: Depending on water hardness, use 1–2L/100–150L water.

UNITE

Type of Adjuvant: Compatibility Agent. **Chemical Composition**: 83.7% acid polyglycols and methyl alcohol. **Benefit**: Improves the compatibility of liquid fertilizer-pesticide mixtures. **Mixing**: 240–1,420mL/378.5 L. A test of physical compatibility of various pesticides and fertilizer mixtures should be performed in a small quantity to determine the exact amount of UNITE and the mixing method to be used.

WATER CONDITIONING AGENTS

(e.g. CHOICE)

WATER-SOLUBLE DYES

(e.g. AQUASHADE)

TABLE 12–3. Adjuvants Used in Ontario**

Brand and Trade Names*	Type of Adjuvant	Chemical Composition	Guaranteed Active	Ont. Sch.	Winter Storage	Manufacturer/ Agent Code
38-F	drift retardant	polyacrylamide	82%	3	C	UAG
AGRAL 90	non-ionic surfactant	nonylphenoxy polyethyoxyethanol	90%	2	C	NRA
AG-SURF	non-ionic surfactant	nonylphenoxy polyethyoxyethanol	92%	2	C	INT
AMIGO	surfactant	phosphate ester	30	2	C	AET
ASSIST OIL CONCENTRATE	mineral oil/surfactant (non herbicidal)	paraffin base mineral oil + surfactant blend	83% + 17%	3	C	BAZ
BASF LIQUID AMMONIUM SULPHATE	liquid fertilizer	ammonium sulphate	490 g/L	6	A	BAZ
CANPLUS 411	mineral oil/surfactant (non herbicidal)	paraffin base mineral oil + surfactant blend	83% + 17%	6	C	ATC
CITOWETT PLUS	non-ionic spreader sticker surfactant	ocylphenoxy-polyethoxy ethanol	50%	3	C	BAZ
COMPANION	non-ionic surfactant	ocylphenoxy-polyethoxy-(9) ethanol	70%	3	C	DWE
CORN OIL	mineral oil (non herbicidal)	paraffin base mineral oil + surfactant blend	98.8% + 1.2%		C	UAG
ENHANCE	cationic surfactant with non-ionic component	tallow fatty acid amine ethoxylate and nonylphenoxy-polyethoxy ethanol	780 g/L	2	A	DWE
FIGHTER F	antifoamer/defoamer	dimethylpolysiloxane		3		UAG
HALT	defoamer	silicone base, neutral	30%		A	DWE
KORNOIL	mineral oil (non herbicidal)	mineral oil + emulsifier	98.5% + 1.5%	3	C	VAR
KORNOIL CONCENTRATE	mineral oil/surfactant (non herbicidal)	paraffin base mineral oil + surfactant blend	85% + 15%	3	C	VAR
LI700	non-ionic surfactant & pH adjuster acidifier	phosphatidylcholine, methylacetic acid, alky polyoxyethylene ether	80%	3	C	UAG
MERGE	surfactant/solvent	surfactant blend + solvent (petroleum hydrocarbons)	50% + 50%	3	B	BAZ
NALCO-TROL	drift control agent	polyvinyl polymer	30%	3		NLC
SIDEKICK	non-ionic liquid spreader/activator	alkylarylpolyoxyethylene glycols, free fatty acids & isopropyl alcohol	900 g/L	3	C	NOR
SPRAY ADJUVANT DEFOAMER	defoamer	demethylpoly-silozane				
SUPER SPREADER STICKER	non-ionic spreader sticker surfactant	ocylphenoxy-polyethoxy ethanol	50%	3	C	UAG
SUPERIOR OIL CONCENTRATE	mineral oil (non herbicidal)	paraffin base mineral oil + surfactant blend	83% + 17%	6		BAT, AET UAG
SURE-MIX	petroleum oil/ surfactant (non-herbicidal)	paraffinic petroleum oil + surfactant blend	60% + 35.6%	6	A	DUQ
SYLGARD 309	organosilicone, non-ionic	silicone polyether	76%	3	C	DCS
TURBOCHARGE	mineral oil/surfactant (non herbicidal)	paraffin base mineral oil + surfactant blend	50% + 39.5%	3	C	SYN

* Mention of a Brand or Trade name in this table does not constitute a guarantee or warranty of the product by the Ontario Weed Committee. Neither does this use signify that these products are approved to the exclusion of comparable products. All TRADE NAMES ARE CAPITALIZED.

** Some products listed may not be registered for use on fruit crops. See product label for registered uses.

TABLE 12–4. Non Selective Herbicides Available for Preplant Site Preparation

CROP	CREDIT, GLYFOS, ROUNDUP, TOUCHDOWN, VANTAGE	VAPAM
fruit	X	X
berries	X	

SPECIAL METHODS OF WEED CONTROL

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)
Preplant-Site Preparation (See Table 12–4, *Non Selective Herbicides Available for Preplant Site Preparation*, on page 204.)			
amitrole AMITROL 240 (231 g/L)	1 to 2 kg/ha 4.2 to 8.4 L/ha	1.68 to 3.36 L/ac	• For dandelions and annual weeds. • For corn, soybeans, white beans, wheat, barley, canola and field peas. • Apply in 100 to 200 L/ha water (40 to 180 L/ac) 10 to 14 days before planting the crop. • Wait 10 to 14 days before tillage and planting (**ONLY** soybeans may be planted 6 days after application when applied at the low rate). • Use additional herbicide treatments to control weed species that emerge after application. • May be tank-mixed with ROUNDUP or PURSUIT where registered.
amitrole AMITROL 240 (231 g/L)	3 to 4 kg/ha 12.5 to 16.5 L/ha	5 to 6.6 L/ac	• For quackgrass, Canada thistle, sow thistle (fall treatment) and annual weeds. • For use **ONLY** before white beans, corn and soybeans. • Apply in 100 to 200 L/ha water (40 to 180 L/ac). • Apply to actively growing weeds up to 10 cm tall in the fall (until heavy frost) or in spring. • Plow or thoroughly disk 10 to 14 days after application. • Cultivation may be required when the crop is emerged to improve weed control.
glyphosate* glyphosate (360 g/L)	0.27 to 4.32 kg/ha 0.75 to 12 L/ha	0.3 to 4.8 L/ac	• For actively growing weeds in the fall, or spring prior to emergence of any crop. • Allow 5 to 7 days translocation time after application before doing any tillage when conditions are good. If cool temperatures follow application, allow additional time for translocation to be completed before disturbing treated weeds. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. • For **annual weeds**, use 0.75 to 3.5 L product/ha (0.3 to 1.4 L/ac). – Use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with the 3.5 L rate. • For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves. – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of one season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm. • For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac) – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – For undisturbed perennials such as sod in non-crop areas, use the highest rate and repeat it when plants regrow to optimum stage.

* Various formulations are available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, page 266. See label for specific use.

SPECIAL METHODS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
glyphosate/glufosinate ammonium ROUNDUP FASTFORWARD PRESEED ((30:1) 310 g/L)	0.465 to 2.604 kg/ha 1.5 to 8.4 L/ha	0.6 to 3.4 L/ac	• For annual grasses up to 15 cm tall, use 0.6 L/ac. • For annual grass and broadleaf weeds up to 15 cm tall, use 1.1 L/ac. • For annual weeds over 15 cm tall, use 1.7 L/ac. • For quackgrass, use 1.5 L/ac. • For dandelions less than 15 cm, use 2 L/ac. • For heavier infestations and for dandelions larger than 15 cm, use 3.4 L/ac.
paraquat GRAMOXONE (200 g/L)	0.55 to 1.1 kg/ha 2.75 to 5.5 L/ha	1.1 to 2.2 L/ac	• Apply to actively growing vegetation at least 3 days prior to crop emergence. • Use the high rate when weeds are above 5 cm in height. • Apply in 300 to 1100 L/ha water (120 to 440 L/ac). • Complete coverage is important. Use higher water volumes on dense vegetation. • Perennial weeds will only be suppressed. • Only emerged weeds will be controlled.

Stale Seedbed and Inter-Row Weeding

The stale seedbed technique is useful when the soil can be worked well before planting, and weeds are allowed to emerge for several weeks. Apply one of the non-selective postemergent herbicides listed here to kill emerged weeds. Seeding or planting directly into the killed weeds with minimal soil disturbance will allow the crop to establish before the next flush of weed emergence. Follow up with either cultivation, hoeing or postemergent or directed herbicides to control later germinating weeds. Where registered, some herbicides can be applied after seeding but before crop emergence.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS
glufosinate ammonium IGNITE (150 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	1.08 to 2 L/ac	• For use **ONLY** in carrot, lettuce and onion crops. • Apply in a minimum of 110 to 330 L/ha (44 to 132 L/ac) of water. • Apply after seeding, but prior to emergence of the crop.
glyphosate* glyphosate (360 g/L) * Various formulations available, see Table 13-1, page 266. See label for specific uses and rates.	0.27 to 1.26 kg/ha 0.75 to 3.5 L/ha	0.3 to 1.4 L/ac	• Till and fertilize soil in early spring. • Allow weeds to grow, and spray weeds just before seeding crop. • Use low rate for small weeds (8 cm), medium rates for weeds 8 to 15 cm and higher rate for weeds over 15 cm tall. • Apply recommended herbicides to control new flushes of weeds or use mechanical means of control.
glyphosate/glufosinate ammonium ROUNDUP FASTFORWARD PRESEED ((30:1) 310 g/L)	0.465 to 2.604 kg/ha 1.5 to 8.4 L/ha	0.6 to 3.4 L/ac	• For annual grasses up to 15 cm tall, use 0.6 L/ac. • For annual grass and broadleaf weeds up to 15 cm tall, use 1.1 L/ac. • For annual weeds over 15 cm tall, use 1.7 L/ac. • For quackgrass, use 1.5 L/ac. • For dandelions less than 15 cm, use 2 L/ac. • For heavier infestations and for dandelions larger than 15 cm, use 3.4 L/ac.
paraquat GRAMOXONE (200 g/L) or diquat REGLONE (200 g/L)	0.6 to 1.1 kg/ha 3 to 5.5 L/ha 0.6 to 1.1 kg/ha 3 to 5.5 L/ha	1.2 to 2.2 L/ac 1.2 to 2.2 L/ac	• For emerged weeds after the crop seed is sown, but before crop emergence. • For use **ONLY** in beans (all types), beets, carrots, cole crops, corn, onions, peas, cucumbers, potatoes, soybeans and turnips. • In inter-row weeding, special low pressure equipment is used to apply the herbicide on emerged weeds without contact with leaves of the crop plants. • For small areas, apply 30 mL product in 10 L water/100 m^2.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, **pg 189 and** ***Notes on Adjuvants***, **pg 198)**
paraquat/ diquat C.I.L.WEED & GRASS KILLER WEED-BAN	See Label		• **Domestic** — Soluble granular formulations for home garden use. Check label for rates.
Spot Treatment with Hand-Held Equipment For Selective Weed Control			
amitrole AMITROL 240 (231 g/L)	3 to 4 kg/ha 12.5 to 16.5 L/ha	 5 to 6.6 L/ac	• Use **ONLY** for non-crop land and pasture. • Thoroughly wet all leaves and stems of weeds. Repeat applications when new growth appears. • Apply to Canada thistle and sow-thistle at early bud to bloom, quackgrass and horsetail at 10 to 15 cm, dandelion when young, toadflax and hoary cress at advanced rosette, milkweed in early summer, poison ivy when fully leafed. • **Do NOT** allow livestock to eat treated vegetation. Keep livestock off treated area until weeds are dead and new growth has emerged.
glyphosate EXPEDITE GRASS & WEED (147 g/L)	0.88 to 4.265 kg/ha 6 to 29 L/ha	 2.4 to 11.6 L/ac	• EXPEDITE herbicides are ready-to-use products which must be applied with the EXPEDITE application system. • This low volume application should not be applied "spray to wet" or runoff. • Material should be calibrated for proper use rate prior to application.
glyphosate* glyphosate (360 g/L) * Various formulations available, see Table 13–1, page 266. See label for specific uses and rates.	0.36 kg to 0.72/100 L 1 L to 2L/100 L		• For actively growing weeds. Direct spray to avoid desirable vegetation. • Allow 5 to 7 days translocation time after application before doing any mowing or tillage when conditions are good. If cool temperatures follow application, allow additional time for translocation to be completed before disturbing treated weeds. • Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom, and quackgrass with 3 to 4 new leaves for best results.
Wick Wiper and Roller Application			
glyphosate* glyphosate (360 g/L) * Various formulations available, see Table 13–1, page 266. See label for specific uses and rates.	0.36 kg/2L water 1 L/2L water		• For use on soybeans, white beans, apple, cherry, peach, pear, plum, grape, strawberries and cranberries. • Apply to weeds that extend above the crop sufficiently to allow good contact with the application equipment. • **Do NOT** contact the crop with the equipment or allow the chemical solution to drip from the applicator on to the crop. • A 33% herbicide mixture (1 L/2 L of water) provides good control of most weeds.

TABLE 12–5. Preplant Herbicide Weed Control Ratings

Notes:
Weed control ratings are given as 0–9 where 0 indicates no control and 9 indicates 90%–100% control under ideal conditions.
Ratings are subjective values based on best available information and give general comparisons based on use as described in this guide.
Under unfavorable conditions (e.g., too dry, too wet, too cold, or poor application) the herbicides may not be as effective as indicated.
Ratings may vary with weed and crop stage and with the timing and rates of the product(s) being used.
Ratings in BOLD indicate the weed is listed on the product label for control or suppression.
Please see product label for more information on registered weed species, product uses and precautions.

Trade Name	Annuals		Perennials															
	annual grasses	annual broadleaves	bindweed, field	chickweed, mouse-eared	dandelion	golden-rod	ground-ivy (creeping Charlie)	horsetail	mallow	milkweed	nutsedge	plantains	poison ivy	quackgrass	sow-thistle	thistle, Canada	vetches
preplant herbicides																	
AMITROL 240	**	**	[a]	?	**9**	[a]	?	7	?	[a]	[a]	8	8	**7**	[a]	**7**	?
CREDIT, GLYPHOS, ROUNDUP, TOUCHDOWN, VANTAGE	**	**	**7**[a]	**9**	**7/8**[d]	?	5	0	5	[a]	**7**	**9**	**8**	**8/9**	[a]	**7**[a]	5
IGNITE	**	**	8[c]	?	**8**	?	?	7[c]	?	6[c]	7[c]	?	?	8[c]	8[c]	8[c]	?
GRAMOXONE	**	**	[b]	[b]	[b]	?	[b]	[b]	[b]	[b]	0	[b]	[b]	**5**	[b]	0	[b]

** Indicates that most annual weeds will be controlled if emerged.
? Insufficient information available to make a rating.
[a] Optimum growth stages for best control of these weeds will not likely be attained prior to planting in early to mid spring.
[b] Top growth only, regrowth can be expected.
[c] Repeated applications may be necessary.
[d] Use higher rates for plants over 15 cm tall or across.

Tree Fruits & Grapes

Cultural Weed Control in Fruit Crops

A successful weed control program must integrate cultural and chemical weed control practices. Growers cannot depend entirely on chemical weed control in fruit crops, since there is a limited spectrum of herbicides registered for these crops.

Perennial Weed Control

It is important to identify and control perennial weeds in the preplanting year. It is very difficult to control perennial weeds once a planting is established because of crop sensitivity to some herbicides and since it is not possible to clean cultivate in established orchards, vineyards, berry crops and nurseries.

The following perennial weeds present serious problems in these crops: quackgrass, bindweed, vetch, wild grape, perennial nightshade, thistles, ground-ivy (creeping Charlie) and burdock. Strawberries, sheep sorrel, toadflax and milkweed also present problems.

Apply systemic herbicides such as glyphosate (e.g. ROUNDUP) or amitrole (e.g. AMITROL 240) to perennial weeds in the preplanting year. Consult the product label and be sure to use the recommended rate for the weed in question. Apply the herbicide at the proper stage of growth of the weed, otherwise only temporary control will be achieved. Repeated cultivations of some perennial weeds, such as bindweed, also provides control.

Site Preparation

A green manure crop such as perennial ryegrass or Sudan grass should be established in the preplanting year following, or in conjunction with, measures to control perennial weeds. This crop provides competition to reduce weed growth as well as improving the soil structure. Non-selective herbicides can be applied before planting the green manure crop and before plowing it under. Short residual selective herbicides such as 2,4-D may be used with the green manure crop, but avoid using herbicides that leave a soil residue that will carry over into the planting year. See *Preplant-Site Preparation,* on page 205.

Mulching

A biodegradable plastic mulch helps to control weeds in the planting strip. A straw mulch also assists in weed control beneath the trees or in the planting strip if it is applied early in the season before the weed seeds germinate. Use mulch that is free of weed seeds and provide enough nitrogen for the plants. Pull the mulch away from around the tree bases for winter rodent protection. You can also apply peastone gravel around the base of the trees. It provides weed control as well as improving drainage, encouraging deeper rooting and discouraging rodents.

Reducing Weed Pressure

Cultivation can provide weed control between the rows. Alternatively, a vigorous sod between the rows prevents weeds from becoming established. It is better to seed in a fescue sod than to rely on a natural sod composed of weed and grass species, since the weeds seed into the herbicide strip.

Prevent weeds from setting seed in adjacent uncropped areas by using cultural or chemical weed control measures. Mowing at regular intervals prevents many weeds from flowering. Try to control weeds that escape before they set seed, by cultural removal or chemical mowing. In some situations, tools such as a weed whip may be of use. Mowers are available that cut close to trees without injury. Mowing, however, does not eliminate weed competition.

Rotating Herbicide Families

(See Table 12–1, *Herbicide Groups for Ontario,* on page 189.)

In perennial crops, it is important to rotate herbicide families to minimize the build-up of seed from weed escapes, including triazine tolerant weeds. Rotation also helps avoid an accumulation of herbicide residues in the soil that may result in crop injury over a period of years, hindering replanting.

APPLES

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205)			
Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60 to 120 L/ac) water. **PREPLANT INCORPORATED (PPI)** — Two incorporations at right angles operating at a depth of 10 cm using a double disk (7 to 10 km/hr) or vibrating shank S-tine cultivator (10 to 13 km/hr) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last. **PREEMERGENCE (PRE)** — Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall. **CAUTION** — Simazine, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of orchard.			
Apples — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil	4.4 to 7 kg/ha		• PRE — Apply to cool, moist soil in spring before weeds emerge or after cultivation.
CASORON 4G (4 Gr)	110 to 175 kg/ha	44 to 70 kg/ac	• **Do NOT** apply if air temps are above 10°C to 15°C to avoid injury from volatilization.
			• **Do NOT** apply until 4 weeks after transplanting.
			• **Do NOT** use on light sandy soils.
			• 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
metribuzin	0.38 to 0.75 kg/ha		• PPI before planting trees.
LEXONE DF (75 DF)	0.5 to 1 kg/ha	0.2 to 0.4 kg/ac	• Make a single application as an orchard floor or planting row treatment.
metribuzin	0.42 to 0.56 kg/ha		• PPI before planting trees as an orchard floor or planting row treatment.
SENCOR 75 DF (75 WG)	0.55 to 0.75 kg/ha	0.22 to 0.3 kg/ac	• Apply once in the planting year **ONLY**.
plus trifluralin	0.6 to 1.155 kg/ha		
TREFLAN EC(480 g/L)	1.25 to 2.4 L/ha	0.5 to 0.96 L/ac	
BONANZA 400 (400 g/L)	1.5 to 2.75 L/ha	0.6 to 1.1 L/ac	
napropamide	4.5 kg/ha		• PRE — Apply after planting trees, but before weeds emerge.
DEVRINOL DF (50 DF)	9 kg/ha	3.6 kg/ac	• Use a directed spray at low pressure.
			• Incorporation by rainfall or irrigation is essential within 2 days of application.
napropamide	3.5 kg/ha		• PRE — Apply in the fall through early spring before weeds emerge.
DEVRINOL DF (50 DF)	7 kg/ha	2.8 kg/ac	• **Do NOT** apply on frozen ground or during harvest.
plus simazine	2.025 kg/ha		• Make **ONLY** one application in the planting year.
PRINCEP NINE-T (90 WG)	2.25 kg/ha	0.9 kg/ac	• Incorporation by rainfall or irrigation is essential within 2 days of application.
napropamide	4.5 kg/ha		• PRE — Apply in the fall through early spring before weeds emerge.
DEVRINOL DF (50 DF)	9 kg/ha	3.6 kg/ac	• **Do NOT** apply on frozen ground or during harvest.
plus terbacil	0.5 kg/ha		• Make 1 application in the planting year **ONLY**.
SINBAR (80 WP)	0.63 kg/ha	0.25 kg/ac	• Incorporation by rainfall or irrigation is essential within 2 days of application.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90 WG) SIMAZINE 80W (80 WP)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha 0.99 to 1.98 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	 0.5 to 0.7 L/ac 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply post planting, before weeds emerge, preferably after rain has settled the soil around the trees. • Apply once in the year of planting. • **Do NOT** use on sandy soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
simazine PRINCEP NINE-T (90 WG) SIMAZINE 80W (80 WP)	1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply post planting, preemergent to weeds, preferably after rain has settled the soil around the trees. • Apply once/season. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soils with less than 2% organic matter.
terbacil SINBAR (80 WP)	1 kg/ha 1.25 kg/ha	 0.5 kg/ac	• PRE — Apply after planting trees, before weeds emerge. • **Do NOT** use on soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
trifluralin TREFLAN EC (480 g/L) BONANZA 400 (400 g/L)	0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI — Apply and incorporate before planting trees. • Apply once in the planting year **ONLY**. • Use at least 100 L/ha water (40 L/ac).
Apples — Year of Planting (Postemergent Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. • **Do NOT** apply more than once/year. • Grasses emerging after the treatment will not be controlled.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3-leaf stage. • **Do NOT** apply closer than 25 days to harvest.
Apples — Year of Planting (Postemergent Broadleaf Herbicides)			
bentazon BASAGRAN (480 g/L) plus oil concentrate ASSIST	0.84 to 1.08 kg/ha 1.75 to 2.25 L/ha 1 to 2 L/ha	 0.7 to 0.9 L/ac 0.4 to 0.8 L/ac	• Direct under trees to small actively growing weeds. • Apply in 100 to 400 L/ha water (40 to 160 L/ac) with at least 275 kPa pressure. • Avoid tree leaves. • Use lower rate of ASSIST under hot, humid conditions. • Make 2 applications, 10 days apart at the low rate, in the planting year **ONLY**.

APPLES

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198**)
clopyralid LONTREL 360 (360 g/L)	0.202 kg/ha 0.56 L/ha	 0.22 L/ac	• For control of vetch at early flowering stage. • Apply in the spring as a spot treatment. • Avoid contact with tree limbs. • **Do NOT** apply closer than 30 days to harvest.
Apples — Established Planting (Soil Applied Grass Herbicides)			
propyzamide KERB (50 WP)	2.25 kg/ha 4.5 kg/ha	 1.8 kg/ac	• PRE — Apply from late Sept. to early Nov. when soil is cool and moist but not frozen. • Use **ONLY** under apple trees established at least 1 year. • 4.5 kg/ha is equivalent to 45 g/100 m².
s-metolachlor DUAL MAGNUM (915 g/L)	1.6 kg/ha 1.75 L/ha	 0.7 L/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
Apples — Established Planting (Soil Applied Broadleaf Herbicides)			
metribuzin LEXONE DF (75 DF)	0.75 kg/ha 1 kg/ha	 0.4 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with tree trunks and leaves.
Apples — Established Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	 44 to 70 kg/ac	• PRE — Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge. • **Do NOT** apply if air temps are above 10°C–15°C to avoid injury from volatilization. • **Do NOT** use on light sandy soils. • 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
linuron LOROX DF (50 DF) AFOLAN F (480 g/L) LINURON 480 (480 g/L)	4.5 kg/ha 9 kg/ha 9.4 L/ha 9.4 L/ha	 3.6 kg/ac 3.76 L/ac 3.76 L/ac	• PRE — Apply as directed spray before weeds are 10 cm high. • Apply in 400 to 600 L/ha water (160 to 240 L/ac). • Add a surfactant. • Avoid contact with fruit, foliage or tree bark with spray or drift. • Use **ONLY** under trees established at least 10 years.
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	 3.6 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge, but not on frozen ground. • Avoid contact with fruit and foliage. • **Do NOT** apply when fruit is on the ground during harvest. • Incorporation by rainfall or irrigation is essential.
s-metolachlor DUAL MAGNUM (915 g/L) plus metribuzin LEXONE DF (75 DF)	1.6 kg/ha 1.75 L/ha 0.75 kg/ha 1 kg/ha	 0.7 L/ac 0.4 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90 WG)	1.6 kg/ha 1.75 L/ha 2.25 kg/ha 2.5 kg/ha	 0.7 L/ac 1 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter. • Late season crabgrass and fall panicum may escape this treatment.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)
simazine PRINCEP NINE-T (90WG) SIMADEX (500 g/L) SIMAZINE 480 (480 g/L)	2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha 4.7 to 9.4 L/ha	 1 to 2 kg/ac 1.8 to 3.6 L/ac 1.88 to 3.76 L/ac	• PRE — Apply in 300 to 1,000 L/ha water (120 to 400 L/ac). • Use only under trees planted for 1 year or more. • Use higher rate on perennial weeds such as quackgrass. • May be combined with glyphosate.
terbacil SINBAR (80 WP)	1.8 to 3.6 kg/ha 2.25 to 4.5 kg/ha	 0.9 to 1.8 kg/ac	• PRE — Apply in 1,000 L/ha water (400 L/ac). • Use only under trees established for at least 3 years.
terbacil SINBAR (80 WP) plus metribuzin LEXONE DF (75 DF)	0.5 kg/ha 0.63 kg/ha 0.75 kg/ha 1 kg/ha	 0.25 kg/ac 0.4 kg/ac	• PRE — Apply as a band under trees before weeds emerge. • Use only 1 application/year. • **Do NOT** use on soil coarser than sandy loams with less than 3% organic matter.
Apples — Established Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. • **Do NOT** apply more than once/year. • Grasses emerging after the treatment will not be controlled.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. • **Do NOT** apply closer than 25 days to harvest.
Apples — Established Planting (Postemergence Broadleaf Herbicides)			
2,4-D 2,4-D AMINE 600 (560 g/L)	0.95 kg/ha 1.7 L/ha	 0.68 L/ac	• For broadleaf weeds, including dandelion, seedling Canada thistle and sow thistle. • Apply in early spring after weeds emerge or postharvest to actively growing weeds. • **Do NOT** apply when useable fruit is on the orchard floor. • **Do NOT** apply closer than 80 days to harvest.
clopyralid LONTREL 360 (360 g/L)	0.202 kg/ha 0.56 L/ha	 0.22 L/ac	• For control of emerged vetch at early flowering. • Apply in the spring as a spot treatment. • Avoid contact with tree limbs. • **Do NOT** apply closer than 30 days to harvest.

APPLES

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Apples — Established Planting (Postemergence Grass & Broadleaf Herbicides)			
amitrole AMITROL 240 (231 g/L)	2.25 to 3.25 kg/ha 9.4 to 13.5 L/ha	 3.76 to 5.4 L/ac	• For all emerged weeds including poison ivy. • Spray to wet entire weed to the ground after foliage has fully developed. • Keep spray off tree trunks as much as possible. • **Do NOT** apply closer than 30 days before harvest.
glufosinate ammonium IGNITE (150 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	 1.08 to 2 L/ac	• Apply as a directed spray before weeds are 30 cm high. • Use 110 to 330 L/ha water (44 to 132 L/ac). • Where weed growth is heavy, use the higher rate and larger water volume. • **Do NOT** apply closer than 40 days to harvest. • For trees established at least 1 year.
glufosinate ammonium IGNITE (150 g/L) plus simazine PRINCEP NINE-T (90WG) SIMADEX (500 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha	 1.08 to 2 L/ac 1 to 2 kg/ac 1.8 to 3.6 L/ac	• To control emerged weeds plus residual control of annual grasses and broadleaf weeds. • Use as a directed spray around the bases of trees established at least 1 year. • **Do NOT** apply closer than 40 days to harvest. • See Precautions on IGNITE and PRINCEP.
glyphosate ROUNDUP (356 g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	0.8 to 4.27 kg/ha 2.25 to 12 L/ha 2 to 4.5 kg/ha 2.25 to 5 kg/ha 2.5 to 5 kg/ha	 0.9 to 4.8 L/ac 0.9 to 2 kg/ac 1 to 2 kg/ac	• To control actively growing weeds, with residual control of germinating weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • Remove all suckers from base of trunks before application. • **Do NOT** apply to trees with "green" bark in the area of application. • See Precautions on ROUNDUP and PRINCEP.
glyphosate* glyphosate (360 g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	 0.9 to 4.8 L/ac	• For actively growing weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • Remove all suckers from base of trunks before application. • **Do NOT** apply to trees with "green" bark in the area of application. • **Do NOT** mow or till weeds for at least 5 to 7 days after application. Wait longer if cool. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. • For **annual weeds**, use 2.25 to 3.5 L product/ha (0.9 to 1.4 L/ac). – Use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with the 3.5 L/ha rate. • For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of 1 season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm.

* Various formulations are available, see Table 13–1, page 266. See label for specific uses and rates.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
			• For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac) – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – **Do NOT** apply closer than 30 days to harvest.
glyphosate*	0.36 kg/2L		• Apply with a rope wick or other similar device when weeds are at the optimum stage. • Avoid contact with the leaves, trucks and suckers. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14. • **Do NOT** apply closer than 30 days to harvest.
glyphosate (360 g/L)	1 L/2L water (33% solution)		
glyphosate*	0.36 to 0.72 kg/100 L		• Use hand held sprayers as a spot treatment if wiper equipment is not available. • Avoid contact with leaves, trucks and suckers. • **Do NOT** apply closer than 30 days before harvest.
glyphosate (360 g/L)	1 to 2 L/100 L water (1 to 2% solution)		
linuron	4.5 kg/ha		• Apply as directed spray before weeds are 10 cm high. • Apply in 400 to 600 L/ha water (160 to 240 L/ac). • Add a surfactant. • Avoid contact with fruit, foliage or tree bark with spray or drift. • Use only under trees established at least 10 years.
LOROX DF (50 DF)	9 kg/ha	3.6 kg/ac	
AFOLAN F (480 g/L)	9.36 L/ha	3.74 L/ac	
paraquat	1.1 kg/ha		• Apply in 1100 L/ha (440 L/ac) water. • For spot spraying, apply 55 mL in 10 L of water sprayed to wet weed foliage. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit. • May be used in mixtures with SINBAR, DEVRINOL or simazine.
GRAMOXONE (200 g/L)	5.5 L/ha	2.2 L/ac	
paraquat	1.1 kg/ha		• Add DEVRINOL to tank first then agitate and add GRAMOXONE. • Apply in 1100 L/ha water (440 L/ac). • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit.
GRAMOXONE (200 g/L)	5.5 L/ha	2.2 L/ac	
plus napropamide	4.5 kg/ha		
DEVRINOL DF (50 DF)	9 kg/ha	3.6 kg/ac	
paraquat	1.1 kg/ha		• To control emerged weeds and provide residual control of germinating weeds. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit. • See Precautions on GRAMOXONE and PRINCEP above.
GRAMOXONE (200 g/L)	5.5 L/ha	2.2 L/ac	
plus simazine	2.25 to 4.5 kg/ha		
PRINCEP NINE-T (90WG)	2.5 to 5 kg/ha	1 to 2 kg/ac	

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, page 266. See label for specific uses and rates.

APRICOTS

Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205.)

Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60 to 120 L/ac) water.

PREPLANT INCORPORATED (PPI) — Two incorporations at right angles operating at a depth of 10 cm using a double disk (7 to 10 km/hr) or vibrating shank S-tine cultivator (10 to 13 km/hr) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

PREEMERGENCE (PRE) — Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

CAUTION — Simazine, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of orchard.

Apricots — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)

Active Ingredient **TRADE NAME (Formulation)**	**RATE (active)** **PRODUCT/HA**	**RATE PRODUCT PER ACRE**	**PRECAUTIONS** (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	0.2 to 0.4 kg/ac	• PPI — Apply before planting trees in the year of planting. • Make single application as an orchard floor or planting row treatment.
metribuzin SENCOR 75 DF (75 WG) plus trifluralin TREFLAN EC (480 g/L) BONANZA 400 (400 g/L)	0.42 to 0.56 kg/ha 0.55 to 0.75 kg/ha 0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	0.22 to 0.3 kg/ac 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI — Apply and incorporate before planting trees. • Apply as an orchard floor or planting row treatment. • Apply **ONCE** in the year of planting only.
napropamide DEVRINOL DF (50 DF) plus simazine PRINCEP NINE-T (90WG)	3.5 kg/ha 7 kg/ha 2 kg/ha 2.25 kg/ha	2.8 kg/ac 0.9 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply on frozen ground. • Make 1 application in the year of planting **ONLY**.
napropamide DEVRINOL 50W (50 WP) plus terbacil SINBAR (80 WP)	4.5 kg/ha 9 kg/ha 0.5 kg/ha 0.63 kg/ha	3.6 kg/ac 0.25 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply on frozen ground. • Make 1 application in the year of planting **ONLY**.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha 1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	0.5 to 0.7 L/ac 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply after planting, before weeds emerge, preferably after rain has settled the soil around the trees. • Apply once in the year of planting. • **Do NOT** use on sandy soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply after planting, before weeds emerge, preferably after rain has settled the soil around the trees. • Apply once/season **ONLY**. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soils with less than 2% organic matter.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
trifluralin TREFLAN EC (480 g/L) BONANZA 400 (400 g/L)	0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI — Apply and incorporate before planting trees. • Use at least 100 L/ha water (40 L/ac). • Apply once in the planting year **ONLY**.
Apricots — Year of Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 2 L/ha	 0.13 to 0.45 L/ac 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. • **Do NOT** apply closer than 25 days to harvest.
Apricots — Year of Planting (Postemergence Broadleaf Herbicides)			
bentazon BASAGRAN (480 g/L) plus surfactant/solvent MERGE	0.84 to 1.08 kg/ha 1.75 to 2.25 L/ha 1 to 2 L/ha	 0.7 to 0.9 L/ac 0.4 to 0.8 L/ac	• Direct under trees to small actively growing weeds., avoiding tree leaves. • Apply in 100 to 400 L/ha water (40 to 160 L/ac) with at least 275 kPa pressure. • Use lower rate of MERGE under hot, humid conditions. • Make 2 applications, 10 days apart at 1.75 L/ha (0.7 L/ac) in the planting year **ONLY**.
Apricots — Established Planting (Soil Applied Grass Herbicides)			
s-metolachlor DUAL MAGNUM (915 g/L)	1.6 kg/ha 1.75 L/ha	 0.7 L/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
Apricots — Established Planting (Soil Applied Broadleaf Herbicides)			
metribuzin LEXONE DF (75 DF)	0.75 kg/ha 1 kg/ha	 0.4 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with tree trunks and leaves.
Apricots — Established Planting (Soil Applied Grass & Broadleaf Herbicides)			
s-metolachlor DUAL MAGNUM (915 g/L) plus metribuzin LEXONE DF (75 DF)	1.6 kg/ha 1.75 L/ha 0.75 kg/ha 1 kg/ha	 0.7 L/ac 0.4 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90WG)	1.6 kg/ha 1.75 L/ha 2.25 kg/ha 2.5 kg/ha	 0.7 L/ac 1 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter. • Late season crabgrass and fall panicum may escape this treatment.

APRICOTS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
terbacil SINBAR (80 WP)	0.5 kg/ha 0.63 kg/ha	0.25 kg/ac	• PRE — Apply as a band under trees before weeds emerge. • Use only 1 application/year. • **Do NOT** use on soil coarser than sandy loams with less than 3% organic matter.
plus metribuzin LEXONE DF (75 DF)	0.75 kg/ha 1 kg/ha	0.4 kg/ac	
Apricots — Established Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. • **Do NOT** apply more than once/ year. • Grasses emerging after the treatment will not be controlled.
sethoxydim POAST ULTRA (450 g/L)	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha	0.13 to 0.45 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. • **Do NOT** apply closer than 25 days to harvest.
plus surfactant/solvent MERGE	1 to 2 L/ha	0.4 to 0.8 L/ac	
Apricots — Established Planting (Postemergence Broadleaf Herbicides)			
2,4-D 2,4-D AMINE 600 (560 g/L)	0.952 kg/ha 1.7 L/ha	0.68 L/ac	• For broadleaf weeds including dandelions, and seedling Canada thistle and sow-thistle. • Apply in early spring after weeds emerge or postharvest to actively growing weeds. • **Do NOT** apply when useable fruit is on the orchard floor. • **Do NOT** closer than 80 days to harvest.
Apricots — Established Planting (Postemergence Grass & Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	0.9 to 4.8 L/ac	• For actively growing weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • Remove all suckers from base of trunks before application. • **Do NOT** apply to trees with "green" bark in the area of application. • **Do NOT** mow or till weeds for at least 5 to 7 days after application. Wait longer if cool. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. – For **annual weeds**, use 2.25 to 3.5 L product/ha (0.9 to 1.4 L/ac). – Use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with the 3.5 L/ha rate.

* Various formulations available, see Table 13–1. See label for specific uses and rates.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
			• For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves. – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of 1 season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm. • For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac) – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – **Do NOT** apply closer than 30 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are at the optimum stage. • Avoid contact with the leaves, trucks and suckers. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14. • **Do NOT** apply closer than 30 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers as a spot treatment if wiper equipment is not available. • Avoid contact with leaves, trucks and suckers. • **Do NOT** apply closer than 30 days before harvest.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	• Apply in 1100 L/ha (440 L/ac) water. • For spot spraying, apply 55 mL in 10 L of water sprayed to wet weed foliage. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit.

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, page 266. See label for specific uses and rates.

CHERRIES & PLUMS

Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205)

Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60 to 120 L/ac) water.

PREPLANT INCORPORATED (PPI) — Two incorporations at right angles operating at a depth of 10 cm using a double disk (7 to 10 km/hr) or vibrating shank S-tine cultivator (10 to 13 km/hr) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

PREEMERGENCE (PRE) — Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

CAUTION — Simazine, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of orchard.

CHERRIES & PLUMS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Cherries & Plums — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	44 to 70 kg/ac	• PRE — Apply to cool, moist soil in spring before weeds emerge or after cultivation. • **Do NOT** apply if air temps are above 10 to 15°C to avoid injury from volatilization. • **Do NOT** apply until 4 weeks after transplanting. • **Do NOT** use on light sandy soils. • 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	0.2 to 0.4 kg/ac	• PPI — Apply in the year of planting only. • Registered on cherries only. • Make a single application as a broadcast treatment or within the planting row.
metribuzin SENCOR 75 DF (75 WG) plus trifluralin TREFLAN EC (480 g/L) BONANZA 400 (400 g/L)	0.42 to 0.56 kg/ha 0.55 to 0.75 kg/ha 0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	0.22 to 0.3 kg/ac 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI — Apply and incorporate before planting trees. • Apply once in the year of planting **ONLY**.
napropamide DEVRINOL DF (50 DF) plus simazine PRINCEP NINE-T (90WG)	3.5 kg/ha 7 kg/ha 2 kg/ha 2.25 kg/ha	2.8 kg/ac 0.9 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply on frozen ground. • Make 1 application in the planting year **ONLY**.
napropamide DEVRINOL DF (50 DF) plus terbacil SINBAR (80 WP)	4.5 kg/ha 9 kg/ha 0.5 kg/ha 0.63 kg/ha	3.6 kg/ac 0.25 kg/ac	• PRE— Apply in the fall through early spring before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply on frozen ground. • Make 1 application in the planting year **ONLY**.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha 1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	0.5 to 0.7 L/ac 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply after planting, before weeds emerge, preferably after rain has settled the soil around the trees. • Apply once in the year of planting. • **Do NOT** use on sandy soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
terbacil SINBAR (80 WP)	1 kg/ha 1.25 kg/ha	0.5 kg/ac	• PRE — Apply after planting trees, before weeds emerge. • **Do NOT** use on soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
trifluralin TREFLAN EC (480 g/L) BONANZA 400 (400 g/L)	0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI — Apply and incorporate before planting trees. • Use at least 100 L/ha water (40 L/ac). • Apply once in the planting year **ONLY**.

Cherries & Plums — Year of Planting (Postemergence Grass Herbicides)

POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.

CHERRIES & PLUMS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
sethoxydim	0.15 to 0.5 kg/ha		• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3-leaf stage. • **Do NOT** apply closer than 25 days to harvest.
POAST ULTRA (450 g/L)	0.32 to 1.1 L/ha	0.13 to 0.45 L/ac	
plus surfactant/solvent			
MERGE	1 to 2 L/ha	0.4 to 0.8 L/ac	
Cherries & Plums — Year of Planting (Postemergence Broadleaf Herbicides)			
bentazon	0.84 to 1.08 kg/ha		• Registered on cherries only. • Direct under trees to small actively growing weeds. • Avoid tree leaves. • Apply in 100 to 400 L/ha water (40 to 160 L/ac) with at least 275 kPa pressure. • Use lower rate of ASSIST under hot, humid conditions. • Make 2 applications, 10 days apart at 1.75 L/ha (0.7 L/ac) in the planting year.
BASAGRAN (480 g/L)	1.75 to 2.25 L/ha	0.7 to 0.9 L/ac	
plus oil concentrate			
ASSIST	1 to 2 L/ha	0.4 to 0.8 L/ac	
Cherries & Plums — Established Planting (Soil Applied Grass Herbicides)			
s-metolachlor	1.6 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
DUAL MAGNUM (915 g/L)	1.75 L/ha	0.7 L/ac	
Cherries & Plums — Established Planting (Soil Applied Broadleaf Herbicides)			
metribuzin	0.75 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with tree trunks and leaves.
LEXONE DF (75 DF)	1 kg/ha	0.4 kg/ac	
Cherries & Plums — Established Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil	4.4 to 7 kg/ha		• PRE — Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge. • **Do NOT** apply if air temps are above 10 to 15°C to avoid injury from volatilization. • **Do NOT** use on light sandy soils. • 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
CASORON 4G (4 Gr)	110 to 175 kg/ha	44 to 70 kg/ac	
linuron	4.5 kg/ha		• PRE — Apply as a directed spray before weeds are 10 cm high. • Apply in 400 to 600 L/ha water (160 to 240 L/ac). • Add a surfactant. • Use **ONLY** under trees established for 10 years. • Keep spray off fruit, leaves and green bark of trees.
LOROX DF (50 DF)	9 kg/ha	3.6 kg/ac	
AFOLAN F (480 g/L)	9.36 L/ha	3.74 L/ac	
LINURON 480 (480 g/L)	9.36 L/ha	3.74 L/ac	
s-metolachlor	1.6 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
DUAL MAGNUM (915 g/L)	1.75 L/ha	0.7 L/ac	
plus metribuzin	0.75 kg/ha		
LEXONE DF (75 DF)	1 kg/ha	0.4 kg/ac	
s-metolachlor	1.6 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter. • Late season crabgrass and fall panicum may escape this treatment.
DUAL MAGNUM (915 g/L)	1.75 L/ha	0.7 L/ac	
plus simazine	2.25 kg/ha		
PRINCEP NINE-T (90WG)	2.5 kg/ha	1 kg/ac	

CHERRIES & PLUMS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
terbacil SINBAR (80 WP) plus metribuzin LEXONE DF (75 DF)	0.5 kg/ha 0.63 kg/ha 0.75 kg/ha 1 kg/ha	 0.25 kg/ac 0.4 kg/ac	• PRE — Apply as a band under trees before weeds emerge. • Registered on cherries only. • Use only 1 application/year. • **Do NOT** use on soil coarser than sandy loams with less than 3% organic matter.
Cherries & Plums — Established Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. • **Do NOT** apply more than once/year. • Grasses emerging after the treatment will not be controlled.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. • **Do NOT** apply closer than 25 days to harvest.
Cherries & Plums — Established Planting (Postemergence Broadleaf Herbicides)			
2,4-D 2,4-D AMINE 600 (560 g/L)	0.952 kg/ha 1.7 L/ha	 0.68 L/ac	• For broadleaf weeds including dandelions, and seedling Canada thistle and sow-thistle. • Apply in early spring after weeds emerge, or postharvest to actively growing weeds. • **Do NOT** apply closer than 80 days to harvest. • **Do NOT** apply when useable fruit is on the orchard floor.
Cherries & Plums — Established Planting (Postemergence Grass & Broadleaf Herbicides)			
glufosinate ammonium IGNITE (150 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	 1.08 to 2 L/ac	• Registered on plums only. • Apply as a directed spray before weeds are 30 cm high. • Use 110 to 330 L/ha water (44 to 132 L/ac). • Where weed growth is heavy, use the higher rate and larger water volume. • **Do NOT** apply closer than 40 days to harvest. • For trees established at least 1 year.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198**)
glyphosate* glyphosate (360 g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	0.9 to 4.8 L/ac	• For actively growing weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • Remove all suckers from base of trunks before application. • **Do NOT** apply to trees with "green" bark in the area of application. • **Do NOT** mow or till weeds for at least 5 to 7 days after application. Wait longer if cool. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. • For **annual weeds**, use 2.25 to 3.5 L product/ha (0.9 to 1.4 L/ac). – Use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with the 3.5 L/ha rate. • For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves. – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of 1 season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm. • For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac). – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – **Do NOT** apply closer than 30 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 kg/2L 1 L/2L water (33% solution)		• Apply with a rope wick or other similar device when weeds are at the optimum stage. • Avoid contact with the leaves, trucks and suckers. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14. • **Do NOT** apply closer than 30 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers as a spot treatment if wiper equipment is not available. • Avoid contact with leaves, trucks and suckers. • **Do NOT** apply closer than 30 days before harvest.
linuron LOROX DF (50 DF) AFOLAN F (480 g/L) LINURON 480 (480 g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha 9.36 L/ha	 3.6 kg/ac 3.74 L/ac 3.74 L/ac	• Apply as a directed spray before weeds are 10 cm high. • Apply in 400 to 600 L/ha water (160 to 240 L/ac). • Add a surfactant. • Use only under trees established for 10 years. • Keep spray off fruit, leaves and green bark of trees.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	 2.2 L/ac	• Apply in 1,000 L/ha water (400 L/ac). • For spot spraying, apply 55 mL in 10 L water sprayed to wet weed foliage. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit. • May be tank mixed with linuron for trees established at least 10 years.

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, page 266. See label for specific uses and rates.

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Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205)			
Cultural Weed Control See *Cultural Weed Control in Fruit Crops* on page 209. Hilling the vines at regular intervals throughout the year will aid in weed control. Be aware that this disruption of the soil will also disturb any residual herbicides. The use of cultivation, mulch or rye cover crops between the rows will provide better water penetration as well as aid in weed control.			
Grapes — Year of Planting			
No herbicides are currently registered for new vineyard. Cultivation after planting is needed to level the soil, and early establishment on trellises or staked will minimize damage from cultivation. Hilling for winter protection can be started in late summer, and will control late germinating weeds. Removing of hills each spring will also aid in weed control.			
Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60 to 120 L/ac) water. **PREEMERGENCE (PRE)** — Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall. **CAUTION** Simazine, KARMEX, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of vineyard.			
Established Grapevines (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	4.4 to 9 kg/ha 110 to 225 kg/ha	44 to 90 kg/ac	• PRE — Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge. • **Do NOT** apply if air temps are above 10 to 15°C to avoid injury from volatilization. • Apply to dormant healthy vines **ONLY**. • **Do NOT** apply to vines until they have been established for at least 2 full years. • For annual weeds, use 110 to 175 kg/ha (44 to 70 kg/ac). • For quackgrass, and broadleaf perennial weeds, use 175 to 225 kg/ha (70 to 90 kg/ac).
diuron KARMEX (80 DF)	1.8 to 5.36 kg/ha 2.25 to 6.7 kg/ha	0.9 to 2.68 kg/ac	• PRE — Apply as a directed spray to a 1m strip under vines before weeds emerge. • Apply in at least 300 L/ha water (120 L/ac). • Use **ONLY** in vineyards established for at least 3 years. • Use 2.25 kg/ha (0.9 kg/ac) in most vineyards. • Use 4.5 kg/ha (1.8 kg/ac) where weed growth is heavy. • Use 6.7 kg/ha (2.68 kg/ac) on heavy clay soils, or on high organic matter content soils. • Apply in spring or fall or both, but **do NOT** exceed 4.5 kg/ha (1.8 kg/ac) in most soils. • May be tank mixed with GRAMOXONE.
napropamide DEVRINOL 50W (50 WP)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • Use **ONLY** under vines that have been established at least 1 year. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply on frozen ground. • Avoid contact with fruit and foliage.

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Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
simazine PRINCEP NINE-T (90 WG) SIMADEX (500 g/L) SIMAZINE 480 (480 g/L)	3.6 to 4.5 kg/ha 4 to 5 kg/ha 7.2 to 9 L/ha 7.5 to 9.4 L/ha	 1.6 to 2 kg/ac 2.9 to 3.6 L/ac 3 to 3.76 L/ac	• PRE — Apply after hills are removed, but before weed emerge. • Apply in at least 300 L/ha water (120 L/ac). • Use higher rates on perennial weeds. • Use **ONLY** in vineyards established for at least 3 years. • May be tank-mixed with IGNITE and glyphosate.
Established Grapevines: Postemergence Grass & Broadleaf Herbicides			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Always use appropriate drift management technology.			
glufosinate ammonium IGNITE (150 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	 1.08 to 2 L/ac	• For vines established at least 3 years. • Apply as a directed spray before annual weeds are 30 cm high. • Avoid suckers and green bark. • Use 110 to 330 L/ha water (44 to 132 L/ac). • Where weed growth is heavy, use the higher rate and larger water volume. • **Do NOT** apply closer than 40 days to harvest.
glufosinate ammonium IGNITE (150 g/L) plus simazine PRINCEP NINE-T (90 WG) SIMADEX (500 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha 3.6 to 4.5 kg/ha 4 to 5 kg/ha 7.2 to 9 L/ha	 1.08 to 2 L/ac 1.6 to 2 kg/ac 2.88 to 3.6 L/ac	• For vines established at least 3 years. • Use as a directed spray avoiding leaves, suckers and green bark on vines. • To control emerged weeds with residual control of germinating annual weeds. • See Precautions for IGNITE and simazine. • **Do not** harvest until 40 days after application.
glyphosate* glyphosate (360 g/L) * Various formulations are available, see Table 13–1. See label for specific uses and rates.	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	 0.9 to 4.8 L/ac	• For actively growing weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • **Do NOT** use on vines less than 3 years old. • Direct spray to avoid leaves and green stems of grapevines. • **Do NOT** mow or till weeds for at least 5 to 7 days after application. Wait longer if cool. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. • For **annual weeds**, use 2.25 to 3.5 L product/ha (0.9 to 1.4 L/ac). – Use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with 3.5 L/ha. • For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves. – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of 1 season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm.

GRAPES

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, **pg 189 and** ***Notes on Adjuvants***, **pg 198**)
			• For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac) – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – **Do NOT** apply closer than 14 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 kg/2L 1 L/2L water (33% solution)		• Apply with a rope wick or other similar device when weeds are at the optimum stage. • Direct spray to avoid leaves and green stems of grapevines. • **Do NOT** apply when weeds are wet. • **Do NOT** use on vines less than 3 years. old. • See *Wiper Applicators for Selective Weed Control* on page 14. • **Do NOT** apply closer than 14 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers as a spot treatment if wiper equipment is not available. • Direct spray to avoid leaves and green stems of grapevines. • **Do NOT** use on vines less than 3 yr old • **Do NOT** apply closer than 14 days before harvest.
glyphosate* glyphosate (360 g/L) plus simazine PRINCEP NINE-T (90WG) SIMAZINE 80W (80WP)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 2.81 to 5.63 kg/ha	 0.9 to 4.8 L/ac 1 to 2 kg/ac 1.12 to 2.25 kg/ac	• For vines established at least 3 years. • Use as a directed spray avoiding leaves, suckers and green bark on vines. • Use higher rates for perennial weeds and heavy weed infestations. • To control emerged weeds with residual control of germinating annual weeds. • See Precautions for IGNITE and simazine. • **Do not** use within 40 days of harvest.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	 2.2 L/ac	• Apply in 1,100 L/ha (440 L/ac) water. • For spot spraying, apply 55mL in 10 L of water sprayed to wet weed foliage. • Use on vines established on trellises. • Avoid contact with green bark, leaves or fruit. • May be tank-mixed with KARMEX.
paraquat GRAMOXONE (200 g/L) plus MCPB/MCPA (15:1) TROPOTOX PLUS (400 g/L)	1.1 kg/ha 5.5 L/ha 1.1 kg/ha 2.75 L/ha	 2.2 L/ac 1.1 L/ac	• Apply in late May or early June, or when bindweed starts to bloom. • Apply in 1,000 L/ha water (400 L/ac) as a low pressure, coarse spray. • For spot spraying, with a shielded nozzle, apply 55mL GRAMOXONE + 30mL TROPOTOX PLUS/10L water/100 m². • Use only when necessary as a spot treatment. TROPOTOX PLUS can injure grapes. • Direct spray to avoid contact with leaves and stems of grapevines.
paraquat GRAMOXONE (200 g/L) plus napropamide DEVRINOL 50W (50 WP)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	 2.2 L/ac 3.6 kg/ac	• Add DEVRINOL to tank first, then agitate and add GRAMOXONE. • Apply in 1,100 L/ha water (440 L/ac).

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario,* on page 266. See label for specific uses and rates.

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Site Preparation Before Planting (See *Special Methods of Weed Control*, page 205.)

Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60 to 120 L/ac) water.

PREPLANT INCORPORATED (PPI) — Two incorporations at right angles operating at a depth of 10 cm using a double disk (7 to 10 km/hr) or vibrating shank S-tine cultivator (10 to 13 km/hr) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

PREEMERGENCE (PRE) — Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

CAUTION — Simazine, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of orchard.

Peaches — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)

Active Ingredient **TRADE NAME (Formulation)**	**RATE (active)** **PRODUCT/HA**	**RATE PRODUCT** **PER ACRE**	**PRECAUTIONS** **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	 44 to 70 kg/ac	• PRE — Apply to cool, moist soil in spring before weeds emerge or after cultivation. • **Do NOT** apply if air temps are above 10°C–15°C to avoid injury from volatilization. • **Do NOT** apply until 4 weeks after transplanting. • **Do NOT** use on light sandy soils. • 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	 0.2 to 0.4 kg/ac	• PPI — Apply and incorporate before planting trees. • Make a single application as a broadcast treatment or within the planting row.
metribuzin SENCOR 75 DF (75 WG) plus trifluralin TREFLAN EC 480 g/L) BONANZA 400 (400 g/L)	0.42 to 0.56 kg/ha 0.55 to 0.75 kg/ha 0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	 0.22 to 0.3 kg/ac 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PRE — Apply and incorporate before planting trees. • Apply once in the year of planting **ONLY.** • Apply as a broadcast treatment or within the planting row.
napropamide DEVRINOL DF (50 DF) plus simazine PRINCEP NINE-T (90 WG)	3.5 kg/ha 7 kg/ha 2 kg/ha 2.25 kg/ha	 2.8 kg/ac 0.9 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • **Do NOT** apply on frozen ground or during harvest. • Make 1 application in the planting year **ONLY.** • Incorporation by rainfall or irrigation is essential within 2 days of application.
napropamide DEVRINOL DF (50 DF) plus terbacil SINBAR (80 WP)	4.5 kg/ha 9 kg/ha 0.5 kg/ha 0.63 kg/ha	 3.6 kg/ac 0.25 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • **Do NOT** apply on frozen ground or during harvest. • Make 1 application in the planting year **ONLY.** • Incorporation by rainfall or irrigation is essential within 2 days of application.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90 WG) SIMAZINE 80W (80 WP)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha 1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	 0.5 to 0.7 L/ac 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply post planting, before weeds emerge, preferably after rain has settled the soil around the trees. • Apply once in the year of planting. • **Do NOT** use on sandy soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.

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Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
simazine	1 to 2 kg/ha		• PRE — Apply post planting, before weeds emerge, preferably after rain has settled the soil around the trees.
PRINCEP NINE-T (90 WG)	1.1 to 2.2 kg/ha	0.44 to 0.88 kg/ac	• Apply once in the year of planting.
SIMAZINE 80W (80 WP)	1.25 to 2.5 kg/ha	0.5 to 1 kg/ac	• **Do NOT** use on sandy soils with less than 2% organic matter.
			• Avoid contact with tree trunks and leaves.
terbacil	1 kg/ha		• PRE — Apply after planting trees, before weeds emerge.
SINBAR (80 WP)	1.25 kg/ha	0.5 kg/ac	• **Do NOT** use on soils with less than 2% organic matter.
			• Avoid contact with tree trunks and leaves.
trifluralin	0.6 to 1.155 kg/ha		• PPI — Apply and incorporate before planting trees.
TREFLAN EC (480 g/L)	1.25 to 2.4 L/ha	0.5 to 0.96 L/ac	• Use at least 100 L/ha water (40 L/ac).
BONANZA 400 (400 g/L)	1.5 to 2.75 L/ha	0.6 to 1.1 L/ac	• Apply as a broadcast treatment or within the planting row.
			• Apply once in the year of planting **ONLY**.
Peaches — Year of Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
sethoxydim	0.15 to 0.5 kg/ha		• Apply to actively growing grasses.
POAST ULTRA (450 g/L)	0.32 to 1.1 L/ha	0.13 to 0.45 L/ac	• For annual grass, use 0.32 L/ha. Apply at the 1- 6 leaf stage.
plus surfactant/solvent			• For volunteer grains, use 0.47 L/ha.
MERGE	1 to 2 L/ha	0.4 to 0.8 L/ac	• For quackgrass, use 1.1 L/ha. Apply up to the 3-leaf stage.
			• **Do NOT** apply closer than 25 days to harvest.
Peaches — Year of Planting (Postemergence Broadleaf Herbicides)			
bentazon	0.84 to 1.08 kg/ha		• Direct under trees to small actively growing weeds.
BASAGRAN (480 g/L)	1.75 to 2.25 L/ha	0.7 to 0.9 L/ac	• Avoid tree leaves.
plus oil concentrate			• Apply in 100 to 400 L/ha water (40 to 160 L/ac) with at least 275 kPa pressure.
ASSIST	1 to 2 L/ha	0.4 to 0.8 L/ac	• Use lower rate of ASSIST under hot, humid conditions.
			• Make 2 applications, 10 days apart at 1.75 L/ha (0.7 L/ac) in the planting year **ONLY**.
Peaches — Established Planting (Soil Applied Grass Herbicides)			
s-metolachlor	1.6 kg/ha		• PRE Apply once/year as a band treatment under the trees before weeds emerge.
DUAL MAGNUM (915 g/L)	1.75 L/ha	0.7 L/ac	• Avoid contact with trunk and leaves of trees.
			• **Do NOT** use on sandy soil with less than 2% organic matter.
Peaches — Established Planting (Soil Applied Broadleaf Herbicides)			
metribuzin	0.75 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge.
LEXONE DF (75 DF)	1 kg/ha	0.4 kg/ac	• Avoid contact with tree trunks and leaves.

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Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*****, pg 189 and *****Notes on Adjuvants*****, pg 198)**
Peaches — Established Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	 44 to 70 kg/ac	• PRE — Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge. • **Do NOT** apply if air temps are above 10 to 15°C to avoid injury from volatilization. • **Do NOT** use on light sandy soils. • 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
linuron LOROX DF (50 DF) AFOLAN F (480 g/L) LINURON 480 (480 g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha 9.36 L/ha	 3.6 kg/ac 3.74 L/ac 3.74 L/ac	• PRE — Apply in 400 to 600 L/ha water (160 to 240 L/ac) as a directed spray before weeds are 12 cm high. • Use only under peach trees established for over 1 year. • Keep spray off leaves, fruit and green bark of trees. • Add a surfactant.
napropamide DEVRINOL 50W (50 WP)	4.5 kg/ha 9 kg/ha	 3.6 kg/ac	• PRE — Incorporation by rainfall or irrigation is essential. • Apply in the fall through early spring before weeds emerge, but not on frozen ground. • Avoid contact with fruit and foliage.
s-metolachlor DUAL MAGNUM (915 g/L) plus metribuzin LEXONE DF (75 DF)	1.6 kg/ha 1.75 L/ha 0.75 kg/ha 1 kg/ha	 0.7 L/ac 0.4 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90WG)	1.6 kg/ha 1.75 L/ha 2.25 kg/ha 2.5 kg/ha	 0.7 L/ac 1 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter. • Late season crabgrass and fall panicum may escape this treatment.
terbacil SINBAR (80 WP)	1.8 to 3.6 kg/ha 2.25 to 4.5 kg/ha	 0.9 to 1.8 kg/ac	• PRE — Apply in 1,000 L/ha of water (400 L/ac). • Use only under trees established for at least 3 years. • Apply as a band under the trees before weeds emerge. • **Do NOT** use on soils with less than 3% organic matter.
terbacil SINBAR (80 WP) plus metribuzin LEXONE DF (75 DF)	0.5 kg/ha 0.63 kg/ha 0.75 kg/ha 1 kg/ha	 0.25 kg/ac 0.4 kg/ac	• PRE — Apply as a band under trees before weeds emerge. • Use only 1 application/year. • **Do NOT** use on soil coarser than sandy loams with less than 3% organic matter.
Peaches — Established Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2-6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3-5 leaf stage. • **Do NOT** apply more than once/year. • Grasses emerging after the treatment will not be controlled.

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Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1-6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3-leaf stage. • **Do NOT** apply closer than 25 days to harvest.
Peaches — Established Planting (Postemergence Broadleaf Herbicides)			
2,4-D 2,4-D AMINE 600 (560 g/L)	0.952 kg/ha 1.7 L/ha	 0.68 L/ac	• To control broadleaf weeds, including dandelion, seedling Canada thistle and sow- thistle. • Apply in early spring after weeds emerge or postharvest to actively growing weeds. • **Do NOT** apply closer than 80 days to harvest. • **Do NOT** apply when useable fruit is on the orchard floor.
Peaches — Established Planting (Postemergence Grass & Broadleaf Herbicides)			
glufosinate ammonium IGNITE (150 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha	 1.08 to 2 L/ac	• Apply as a directed spray before weeds are 30 cm high. • Use 110 to 330 L/ha water (44 to 132 L/ac). • Where weed growth is heavy, use the higher rate and larger water volume. • **Do NOT** apply closer than 40 days to harvest. • For trees established at least 1 year.
glyphosate* glyphosate (360 g/L) * Various formulations are available, Table 13–1 on page 266. See label for specific uses and rates.	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	 0.9 to 4.8 L/ac	• For actively growing weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • Remove all suckers from base of trunks before application. • **Do NOT** apply to trees with "green" bark in the area of application. • **Do NOT** mow or till weeds for at least 5 to 7 days after application. Wait longer if cool. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. • For **annual weeds**, use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Use 2.25 to 3.5 L product/ha (0.9 to 1.4 L/ac). – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with 3.5 L/ha. • For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves. – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of 1 season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm. • For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac) – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – **Do NOT** apply closer than 30 days to harvest.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
glyphosate* glyphosate (360 g/L)	0.36 kg/2L 1 L/2L water (33% solution)		• Apply with a rope wick or other similar device when weeds are at the optimum stage. • Avoid contact with the leaves, trucks and suckers. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14. • **Do NOT** apply closer than 30 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers as a spot treatment if wiper equipment is not available • Avoid contact with leaves, trucks and suckers. • **Do NOT** apply closer than 30 days before harvest.
linuron LOROX DF (50 DF) AFOLAN F (480 g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha	 3.6 kg/ac 3.74 L/ac	• Apply as directed spray before weeds are 10 cm high • Apply in 400 to 600 L/ha water (160 to 240 L/ac). • Add a surfactant. • Avoid contact with fruit, foliage or tree bark with spray or drift. • Use only under trees established at least 10 years
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	 2.2 L/ac	• Apply in 1,100 L/ha (440 L/ac) water. • For spot spraying, apply 55 mL in 10 L of water sprayed to wet weed foliage. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit. • May be used in mixtures with DEVRINOL
paraquat GRAMOXONE (200 g/L) plus napropamide DEVRINOL DF (50 DF)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	 2.2 L/ac 3.6 kg/ac	• Add DEVRINOL to tank first then agitate and add GRAMOXONE. • Apply in 1,100 L/ha water (440 L/ac). • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit.

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266. See label for specific uses and rates.

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Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)

Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205).

Recommended rates /ha or /ac refer to area actually treated with herbicide. Unless specified, apply all treatments in 150 to 300 L/ha (60 to 120 L/ac) water.

PREPLANT INCORPORATED (PPI) — Two incorporations at right angles operating at a depth of 10 cm using a double disk (7 to 10 km/hr) or vibrating shank S-tine cultivator (10 to 13 km/hr) are required unless otherwise stated. Cultivation-type equipment used for herbicide incorporation is known to spread perennial weeds to previously uninfested areas. Special attention should be directed toward machinery cleanliness, and/or treating fields with perennial weeds last.

PREEMERGENCE (PRE) — Rainfall at 15 to 20 mm within 7 to 10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

CAUTION — Simazine, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of orchard.

PEARS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Pears — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	4.4 to 7 kg/ha 110 to 175 kg/ha	 44 to 70 kg/ac	• PRE — Apply to cool, moist soil in spring before weeds emerge or after cultivation. • **Do NOT** apply if air temps are above 10 to 15°C to avoid injury from volatilization. • **Do NOT** apply until 4 weeks after transplanting. • **Do NOT** use on light sandy soils. • 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
metribuzin LEXONE DF (75 DF)	0.38 to 0.75 kg/ha 0.5 to 1 kg/ha	 0.2 to 0.4 kg/ac	• PPI before planting trees. • Make a single application as an orchard floor or planting row treatment.
metribuzin SENCOR 75 DF (75 WG) plus trifluralin TREFLAN EC (480 g/L) BONANZA 400 (400 g/L)	0.42 to 0.56 kg/ha 0.55 to 0.75 kg/ha 0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	 0.22 to 0.3 kg/ac 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI before planting trees as an orchard floor or planting row treatment. • Apply once in the planting year **ONLY**.
napropamide DEVRINOL DF (50 DF) plus simazine PRINCEP NINE-T (90 WG)	3.5 kg/ha 7 kg/ha 2 kg/ha 2.25 kg/ha	 2.8 kg/ac 0.9 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • **Do NOT** apply on frozen ground or during harvest. • Make **ONLY** 1 application in the planting year. • Incorporation by rainfall or irrigation is essential within 2 days of application.
napropamide DEVRINOL DF (50 DF) plus terbacil SINBAR (80 WP)	4.5 kg/ha 9 kg/ha 0.5 kg/ha 0.63 kg/ha	 3.6 kg/ac 0.25 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge. • **Do NOT** apply on frozen ground or during harvest. • Make 1 application in the planting year **ONLY**. • Incorporation by rainfall or irrigation is essential within 2 days of application.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90 WG) SIMAZINE 80W (80 WP)	1.14 to 1.6 kg/ha 1.25 to 1.75 L/ha 1 to 2 kg/ha 1.1 to 2.2 kg/ha 1.25 to 2.5 kg/ha	 0.5 to 0.7 L/ac 0.44 to 0.88 kg/ac 0.5 to 1 kg/ac	• PRE — Apply post planting, before weeds emerge, preferably after rain has settled the soil around the trees. • Apply once in the year of planting. • **Do NOT** use on sandy soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
terbacil SINBAR (80 WP)	1 kg/ha 1.25 kg/ha	 0.5 kg/ac	• PRE— Apply after planting trees, before weeds emerge. • **Do NOT** use on soils with less than 2% organic matter. • Avoid contact with tree trunks and leaves.
trifluralin TREFLAN EC(480 g/L) BONANZA 400 (400 g/L)	0.6 to 1.155 kg/ha 1.25 to 2.4 L/ha 1.5 to 2.75 L/ha	 0.5 to 0.96 L/ac 0.6 to 1.1 L/ac	• PPI — Apply and incorporate before planting trees. • Use at least 100 L/ha water (40 L/ac). • Apply as a broadcast treatment or within the planting row. • Apply once in the year of planting **ONLY**.

Pears — Year of Planting (Postemergence Grass Herbicides)

POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
fluazifop-p-butyl	0.125 to 0.25 kg/ha		• Apply to actively growing grasses.
VENTURE L (125 g/L)	1 L to 2 L /ha	0.4 to 0.8 L/ac	• For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage.
			• For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage.
			• **Do NOT** apply more than once/year.
			• Grasses emerging after the treatment will not be controlled.
sethoxydim	0.15 to 0.5 kg/ha		• Apply to actively growing grasses.
POAST ULTRA (450 g/L)	0.32 to 1.1 L/ha	0.13 to 0.45 L/ac	• For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage.
plus surfactant/solvent			• For volunteer grains, use 0.47 L/ha.
MERGE	1 to 2 L/ha	0.4 to 0.8 L/ac	• For quackgrass, use 1.1 L/ha. Apply up to the 3-leaf stage.
			• **Do NOT** apply closer than 25 days to harvest.
Pears — Year of Planting (Postemergence Broadleaf Herbicides)			
bentazon	0.84 to 1.08 kg/ha		• Direct under trees to small actively growing weeds.
BASAGRAN (480 g/L)	1.75 to 2.25 L/ha	0.7 to 0.9 L/ac	• Apply in 100 to 400 L/ha water (40 to 160 L/ac) with at least 275 kPa pressure.
plus oil concentrate			• Avoid tree leaves.
ASSIST	1 to 2 L/ha	0.4 to 0.8 L/ac	• Use lower rate of ASSIST under hot, humid conditions.
			• Make 2 applications, 10 days apart at the low rate, in the planting year **ONLY**.
Pears — Established Planting (Soil Applied Grass Herbicides)			
propyzamide	2.25 kg/ha		• PRE — Apply from late Sept.Nov. to early Nov. when soil is cool and moist but not frozen.
KERB (50 WP)	4.5 kg/ha	1.8 kg/ac	• Use **ONLY** under apple trees established at least 1 year.
			• 4.5 kg/ha is equivalent to 45 g/100 m^2.
s-metolachlor	1.6 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge.
DUAL MAGNUM (915 g/L)	1.75 L/ha	0.7 L/ac	• Avoid contact with trunk and leaves of trees.
			• **Do NOT** use on sandy soil with less than 2% organic matter.
Pears — Established Planting (Soil Applied Broadleaf Herbicides)			
metribuzin	0.75 kg/ha		• PRE — Apply once/year as a band treatment under the trees before weeds emerge.
LEXONE DF (75 DF)	1 kg/ha	0.4 kg/ac	• Avoid contact with tree trunks and leaves.
Pears — Established Planting (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil	4.4 to 7 kg/ha		• PRE — Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge.
CASORON 4G (4 Gr)	110 to 175 kg/ha	44 to 70 kg/ac	• **Do NOT** apply if air temps are above 10°C–15°C to avoid injury from volatilization.
			• **Do NOT** use on light sandy soils.
			• 70 g of CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac).
linuron	4.5 kg/ha		• PRE — Apply as directed spray before weeds are 10 cm high.
LOROX DF (50 DF)	9 kg/ha	3.6 kg/ac	• Apply in 400 to 600 L/ha water (160 to 240 L/ac). Add a surfactant.
AFOLAN F (480 g/L)	9.36 L/ha	3.74 L/ac	• Avoid contact with fruit, foliage or tree bark with spray or drift.
LINURON 480 (480 g/L)	9.36 L/ha	3.74 L/ac	• Use **ONLY** under trees established at least 10 years.

PEARS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	 3.6 kg/ac	• PRE — Apply in the fall through early spring before weeds emerge, but not on frozen ground. Avoid contact with fruit and foliage. • **Do NOT** apply when fruit is on the ground during harvest. • Incorporation by rainfall or irrigation is essential.
s-metolachlor DUAL MAGNUM (915 g/L) plus metribuzin LEXONE DF (75 DF)	1.6 kg/ha 1.75 L/ha 0.75 kg/ha 1 kg/ha	 0.7 L/ac 0.4 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter.
s-metolachlor DUAL MAGNUM (915 g/L) plus simazine PRINCEP NINE-T (90 WG)	1.6 kg/ha 1.75 L/ha 2.25 kg/ha 2.5 kg/ha	 0.7 L/ac 1 kg/ac	• PRE — Apply once/year as a band treatment under the trees before weeds emerge. • Avoid contact with trunk and leaves of trees. • **Do NOT** use on sandy soil with less than 2% organic matter. • Late season crabgrass and fall panicum may escape this treatment.
simazine PRINCEP NINE-T (90 WG) SIMADEX (500 g/L) SIMAZINE 480 (480 g/L)	2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha 4.7 to 9.4 L/ha	 1 to 2 kg/ac 1.8 to 3.6 L/ac 1.88 to 3.76 L/ac	• PRE — Apply in 300 to 1,000 L/ha water (120 to 400 L/ac). • Use only under trees planted for 1 year or more. • Use higher rate on perennial weeds such as quackgrass. • May be combined with glyphosate.
terbacil SINBAR (80 WP) plus metribuzin LEXONE DF (75 DF)	0.5 kg/ha 0.63 kg/ha 0.75 kg/ha 1 kg/ha	 0.25 kg/ac 0.4 kg/ac	• PRE — Apply as a band under trees before weeds emerge. • Use only 1 application/year. • **Do NOT** use on soil coarser than sandy loams with less than 3% organic matter.
Pears — Established Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. • **Do NOT** apply more than once/year. • Grasses emerging after the treatment will not be controlled.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1-6 leaf stage. • For volunteer grains, use 0.47 L/ha. • For quackgrass, use 1.1 L/ha. Apply up to the 3-leaf stage. • **Do NOT** apply closer than 25 days to harvest.

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Pears — Established Planting (Postemergence Broadleaf Herbicides)			
2,4-D 2,4-D AMINE 600 (560 g/L)	0.952 kg/ha 1.7 L/ha	 0.68 L/ac	• To control broadleaf weeds, including dandelion, seedling Canada thistle and sow-thistle. • Apply in early spring after weeds emerge or postharvest to actively growing weeds. • **Do NOT** apply closer than 80 days to harvest. • **Do NOT** apply when useable fruit is on the orchard floor.
Pears — Established Planting (Postemergence Grass & Broadleaf Herbicides)			
glufosinate ammonium IGNITE (150 g/L)	0.405 to 0.705 kg/ha 2.7 to 5 L/ha	 1.08 to 2 L/ac	• Apply as a directed spray before weeds are 30 cm high. • Use 110 to 330 L/ha water (44 to 132 L/ac). • Where weed growth is heavy, use the higher rate and larger water volume. • **Do NOT** apply closer than 40 days to harvest. • For trees established at least 1 year.
glufosinate ammonium IGNITE (150 g/L) plus simazine PRINCEP NINE-T (90WG) SIMADEX (500 g/L)	0.405 to 0.75 kg/ha 2.7 to 5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha 4.5 to 9 L/ha	 1.08 to 2 L/ac 1 to 2 kg/ac 1.8 to 3.6 L/ac	• To control emerged weeds plus residual control of annual grasses and broadleaf weeds. • Use as a directed spray around the bases of trees established at least 1 year. • **Do NOT** apply closer than 40 days to harvest. • See Precautions on IGNITE and PRINCEP.
glyphosate* glyphosate (360 g/L)	0.81 to 4.32 kg/ha 2.25 to 12 L/ha	 0.9 to 4.8 L/ac	• For actively growing weeds. • Apply in 200 to 300 L/ha water (80 to 120 L/ac) as a directed spray. • Remove all suckers from base of trunks before application. • **Do NOT** apply to trees with "green" bark in the area of application. • **Do NOT** mow or till weeds for at least 5 to 7 days after application. Wait longer if cool. • Only weeds emerged at application time will be controlled. Additional weed control programs will be necessary to control weeds germinating later. • Repeat application to regrowth may be necessary for complete control. • For **annual weeds**, use 2.25 to 3.5 L product/ha (0.9 to 1.4 L/ac). – Use 50 to 100 L/ha water (20 to 40 L/ac) for the low rate, or use a surfactant with larger water volumes. – Water volumes of 100 to 300 L/ha water (40 to 120 L/ac) can be used with 3.5 L/ha. • For **dandelions and quackgrass**, use 2.5 to 7 L product /ha (1 to 2.8 L/ac). – Apply when plants have at least 3 to 4 new leaves. – The low rate (2.5 L/ha (1 L/ac)) will provide a minimum of 1 season control while higher rates (4.75 to 7 L/ha (1.9 to 2.8 L/ac)) will provide longer term control. – For dandelion control apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5 to 5 L/ha (1.4 to 2 L/ac) if larger than 15 cm. • For **perennial broadleaf weeds**, use 7 to 12 L product/ha (2.8 to 4.8 L/ac) – Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. – **Do NOT** apply closer than 30 days to harvest.

* Various formulations are available, see Table 13-1. See label for specific uses and rates.

PEARS

Active Ingredient TRADE NAME (Formulation)	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are at the optimum stage. • Avoid contact with the leaves, trucks and suckers. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14. • **Do NOT** apply closer than 30 days to harvest.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers as a spot treatment if wiper equipment is not available. • Avoid contact with leaves, trucks and suckers. • **Do NOT** apply closer than 30 days before harvest.
linuron LOROX DF (50 DF) AFOLAN F (480 g/L) LINURON 480 (480 g/L)	4.5 kg/ha 9 kg/ha 9.36 L/ha 9.36 L/ha	 3.6 kg/ac 3.74 L/ac 3.74 L/ac	• Apply as directed spray before weeds are 10 cm high. • Apply in 400 to 600 L/ha water (160 to 240 L/ac). • Add a surfactant. • Avoid contact with fruit, foliage or tree bark with spray or drift. • Use only under trees established at least 10 years.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	 2.2 L/ac	• Apply in 1,100 L/ha (440 L/ac) water. • For spot spraying, apply 55 mL in 10 L of water sprayed to wet weed foliage. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit. • May be used in mixtures with DEVRINOL or PRINCEP.
paraquat GRAMOXONE (200 g/L) plus napropamide DEVRINOL DF (50 DF)	1.1 kg/ha 5.5 L/ha 4.5 kg/ha 9 kg/ha	 2.2 L/ac 3.6 kg/ac	• Add DEVRINOL to tank first then agitate and add GRAMOXONE. • Apply in 1,100 L/ha water (440 L/ac). • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit.
paraquat GRAMOXONE (200 g/L) plus simazine PRINCEP NINE-T (90WG)	1.1 kg/ha 5.5 L/ha 2.25 to 4.5 kg/ha 2.5 to 5 kg/ha	 2.2 L/ac 1 to 2 kg/ac	• To control emerged weeds and provide residual control of germinating weeds. • Use on trees established 1 year or more. • Avoid contact with green bark, leaves or fruit. • See Precautions on GRAMOXONE and PRINCEP above.

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario,* on page 266. See label for specific uses and rates.

Fruit Crop Herbicide Weed Control Ratings

Notes:

Weed control ratings are given as 0–9 where 0 indicates no control and 9 indicates 90%–100% control under ideal conditions.

Ratings are subjective values based on best available information and give general comparisons based on use as described in this guide.

Under unfavorable conditions (e.g., too dry, too wet, too cold, or poor application) the herbicides may not be as effective as indicated.

Ratings may vary with weed and crop stage and with the timing and rates of the product(s) being used.

Ratings in BOLD indicate the weed is listed on the product label for control or suppression.

Please see product label for more information on registered weed species, product uses and precautions.

TABLE 12–6. Fruit Crop Herbicide Weed Control Ratings

TRADE NAME	Crop Registrations										Annual Grasses						Annual Broadleaves						Perennial Weeds																	
	apples	apricots	blackberries	cherries/plums	currants/gooseberries	grapes	highbush blueberries	peaches	pears	raspberries	barnyard grass	crabgrass	fall panicum	foxtail	old witch grass	sandbur	chickweed, common	lady's-thumb	lamb's-quarters	mustards	pigweeds	ragweed	bindweed, field	chickweed, mouse-eared	dandelion	goldenrod	grape, wild	ground-ivy (creeping charlie)	mallow	milkweed	nightshade, climbing	nutsedge	plantains	poison-ivy	quackgrass	sow-thistle	stinging nettle	thistle, Canada	vetches	virginia creeper
soil applied grass and broadleaf herbicides																																								
CASORON	✓		✓	✓		✓	✓	✓	✓	✓	7	**6**	6	**6**	7	?	**8**	**7**	**8**	**3**	**8**	4	**7**	7	**7**	?	5	6	?	?	?	**7**	**7**	5	**7**	**7**	?	**7**	**7**	?
KARMEX						✓					9	**5**	5	**5**	8	?	9	9	**9**	9	**8**	**9**	?	?	5	?	?	?	?	5	?	5	?	?	5	5	?	5	?	?
LOROX, AFOLAN F, LINURON 480	✓			✓				✓	✓		**7**	**6**	5	**8**	**9**	?	**9**	**7**	**9**	7	**8**	**8**	5	8	?	?	?	?	?	5	?	8	?	?	7	8	?	7	?	?
DUAL MAGNUM	✓	✓		✓				✓	✓		**9**	**9**	**8**	**9**	**9**	?	6	2	7	2	**8**	4	0	?	5	?	?	?	?	0	?	**8**	5	?	0	0	0	0	0	0
LEXONE	✓	✓		✓[1]				✓			7	**8**	**9**	**8**	**9**	?	**9**	**9**	**9**	**9**	**8**	**8**	2	?	?	?	?	?	?	2	2	**2**	?	?	2	2	?	2	2	0
DEVRINOL	✓		✓			✓	✓	✓	✓	✓	**8**	**9**	**8**	**8**	8	**8**	**7**	6	**8**	5	**8**	**7**	?	?	5	?	?	?	?	5	?	5	5	1	5	5	?	5	1	?
KERB	✓								✓		**8**	**7**	**8**	**8**	**9**	8	**9**	7	9	8	9	7	?	?	?	?	?	?	?	6	?	6	?	?	**6**	6	?	?	?	?
PRINCEP NINE-T, SIMADEX, SIMAZINE 480	✓	✓	✓			✓	✓	✓	✓	✓	**8**	**8**	6	**8**	8	?	8	**9**	**9**	9	9	**8**	2	?	5	?	?	?	?	0	?	5	?	?	6	5	?	5	0	?
SINBAR	✓	✓[2]		✓[2]			✓	✓	✓[2]		**8**	**7**	8	**8**	8	5	**9**	7	**8**	**8**	**7**	**7**	6	8	6	?	?	?	?	6	?	6	8	?	6	1	?	6	1	?
TREFLAN	✓[2]	✓[2]		✓[2]				✓[2]	✓[2]		**9**	**9**	8	**8**	8	?	**7**	6	**8**	3	**8**	4	2	?	2	1	1	1	0	2	2	?	2	0	2	2	2	2	2	0

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266.

Indicates crop registration. [1] For cherries only. [2] Non-bearing trees only. [3] For plums only. [a] Top growth only; regrowth can be expected. [b] use higher rates when larger than 15 cm tall or across

TABLE 12–6. Fruit Crop Herbicide Weed Control Ratings (cont'd)

TRADE NAME	Crop Registrations										Annual Grasses						Annual Broadleaves						Perennial Weeds																	
	apples	apricots	blackberries	cherries/plums	currants/gooseberries	grapes	highbush blueberries	peaches	pears	raspberries	barnyard grass	crabgrass	fall panicum	foxtail	old witch grass	sandbur	chickweed, common	lady's-thumb	lamb's-quarters	mustards	pigweeds	ragweed	bindweed, field	chickweed, mouse-eared	dandelion	goldenrod	grape, wild	ground-ivy (creeping charlie)	mallow	milkweed	nightshade, climbing	nutsedge	plantains	poison-ivy	quackgrass	sow-thistle	stinging nettle	thistle, Canada	vetches	virginia creeper
soil applied grass and broadleaf tank-mixes																																								
DUAL MAGNUM + LEXONE	✓	✓		✓				✓	✓		9	9	9	9	9	?	9	9	9	9	8	8	2	?	5	?	?	?	?	2	2	8	?	?	2	2	2	2	2	0
DUAL MAGNUM + PRINCEP NINE-T	✓	✓		✓				✓	✓		9	9	9	9	9	?	9	9	9	9	8	8	2	?	5	?	?	?	?	0	?	8	?	?	6	5	?	5	0	?
SENCOR + TREFLAN	✓[2]	✓[2]		✓[2]				✓[2]	✓[2]		8	8	9	9	9	?	9	9	9	9	8	8	2	?	2	1	1	1	0	2	2	2	2	0	2	2	2	2	2	0
DEVRINOL + PRINCEP NINE-T	✓[2]	✓[2]		✓[2]				✓[2]	✓[2]		8	9	8	8	8	8	7	9	9	9	9	8	2	?	5	2	2	2	2	5	2	5	5	1	6	5	2	5	1	0
DEVRINOL + SINBAR	✓[2]	✓[2]		✓[2]				✓[2]	✓[2]		8	9	8	8	8	8	9	7	8	8	8	7	6	?	6	2	2	2	2	6	2	6	8	1	6	5	2	6	1	0
SINBAR + LEXONE	✓	✓		✓[1]				✓	✓		8	8	9	9	9	?	9	9	9	9	8	8	?	8	6	2	2	2	2	6	2	6	8	2	6	2	2	6	2	0
postemergent grass herbicides																																								
VENTURE L	✓	✓		✓			✓	✓	✓	✓	9	9	9	9	9	?	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0
POAST ULTRA	✓	✓		✓			✓	✓	✓	✓	8	8	9	8	9	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
postemergent broadleaf herbicides																																								
BASAGRAN	✓[2]	✓[2]		✓[1,2]				✓[2]	✓[2]		0	0	0	0	0	0	8	9	9	8	8	8	7	?	?	?	?	?	?	5	2	8	2	?	2	5	8[a]	6	5	?
2,4-D*	✓	✓	✓	✓				✓	✓	✓	0	0	0	0	0	?	7	6	8	9	9	8	5	2	8	2	5	2	2	2	?	2	8	?	2	6	?	8	5	?
postemergent grass and broadleaf herbicides																																								
AMITROL-T	✓										?	?	8	?	?	?	7	6	6	?	5	?	?	?	9	?	2	?	?	8	?	8	?	8	8	8	6	8	8	?
IGNITE	✓			✓[3]		✓		✓	✓		9	9	9	9	9	?	9	9	9	8	9	9	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	5	9	8[a]	8[a]	8[a]	8[a]
GLYPHOS, ROUNDUP, TOUCHDOWN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	9	9	9	8	9	8/9[a]	?	8	5	5	9	?	5	9	9	9	9	5	9	5[a]	8[a]
GRAMOXONE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	9	9	9	9	9	?	9	9	9	9	9	9	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]
GRAMOXONE + DEVRINOL	✓					✓		✓	✓		9	9	9	9	9	?	9	9	9	9	9	9	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]	8[a]

* Various formulations available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266.
Indicates crop registration. [1] For cherries only. [2] Non-bearing trees only. [3] For plums only. [a] Top growth only; regrowth can be expected. [b] use higher rates when larger than 15 cm tall or across

BERRY CROPS

Cultural Weed Control in Berry Crops

A successful weed control program must integrate cultural and chemical weed control practices. Growers cannot depend entirely on chemical weed control in berry crops, since there is a limited spectrum of herbicides registered for these crops.

Perennial Weed Control

It is important to identify and control perennial weeds in the preplanting year. It is very difficult to control perennial weeds once a planting is established because of crop sensitivity to some herbicides and since it is not possible to clean cultivate in established berry crops.

The following perennial weeds present serious problems in these crops; quackgrass, bindweed, vetch, wild grape, perennial nightshade, thistles, ground-ivy (creeping Charlie) and burdock. In strawberries, sheep sorrel, toadflax and milkweed also present problems.

Systemic herbicides such as glyphosate (e.g. ROUNDUP) or amitrole (e.g. AMITROL 240) should be applied to perennial weeds in the preplanting year. Consult the product label and be sure to use the recommended rate for the weed in question. Apply the herbicide at the proper stage of growth of the weed, otherwise only temporary control will be achieved. Repeated cultivations of some perennial weeds such as bindweed will also provide control.

Site Preparation

A green manure crop such as perennial ryegrass or Sudan grass should be established in the preplanting year following or in conjunction with measures to control perennial weeds. This crop provides competition to reduce weed growth and improves the soil structure. Non-selective herbicides can be applied before planting the green manure crop and before plowing it under. Short residual selective herbicides such as 2,4-D may be used with the green manure crop, but avoid using herbicides that leave a soil residue that will carry over into the planting year.

Mulching

For bramble and bush fruit, a biodegradable plastic mulch could be used for weed control in the planting strip. Straw mulch will also assist in weed control beneath the plants or in the planting strip if it is applied early in the season before the weed seeds germinate. Use mulch that is free of weed seeds and ensure that enough nitrogen is provided for the plants. The mulch should be pulled away from around the plants for winter rodent protection.

For strawberries, use of straw mulch before weeds germinate can help control weeds. Some growers are trying plasticulture as a way to improve weed control.

Reducing Weed Pressure

Cultivation can provide weed control between the rows. In bramble and bush fruit, a vigorous sod between the rows will prevent weeds from becoming established. It is better to seed in a fescue sod than to rely on a natural sod composed of weed and grass species, since the weeds will seed into the herbicide strip.

Prevent weeds from setting seed in adjacent uncropped areas by using cultural or chemical weed control measures. Mowing at regular intervals will prevent many weeds from flowering. Try to control weeds which escape before they set seed, by cultural removal or chemical mowing. In some situations, tools such as a weed whip may be of use. Mowers are available which will cut close to the plants without injury. Mowing, however, will not eliminate weed competition.

Rotating Herbicide Families

(See Table 12–1, *Herbicide Groups for Ontario,* on page 189.)

In perennial crops, rotation of herbicide families is important to minimize the building up of seed from weed escapes, including triazine tolerant weeds. Rotation helps prevent an accumulation of herbicide residues in the soil that may result in crop injury over a period of years and may hinder replanting.

BLUEBERRIES, HIGHBUSH

<table>
<tr><th>Active Ingredient
TRADE NAME (Formulation</th><th>RATE (active)
PRODUCT/HA</th><th>RATE PRODUCT
PER ACRE</th><th>PRECAUTIONS
(For more information see <i>Herbicides for Fruit Crops</i>, pg 189 and <i>Notes on Adjuvants</i>, pg 198)</th></tr>
<tr><td colspan="4">CULTURAL WEED CONTROL see previous page.
Mulching: A biodegradable mulch could be used for weed control within the plant row. Sawdust mulch will assist in weed control if it is applied early in the season before the weed seeds germinate. Apply old sawdust 5 cm thick. The mulch will not prevent the germination of weed seeds that may blow onto the surface of the mulch.
In subsequent years, the organic matter in the mulch may tie up and thus reduce the effectiveness of certain residual herbicides.
The nitrogen requirements of the crop will change as the mulch is degraded. Initially, nitrogen will be consumed by microorganisms, thus necessitating higher rates of nitrogen fertilizer. Later, as the sawdust is degrading, nitrogen will be released and the crop may require less nitrogen fertilizer than an unmulched crop. It may take 2 years or more for sawdust mulch to significantly decompose. Adjust fertilizer rates according to mulch breakdown, plant growth and leaf nutrient analysis results.</td></tr>
<tr><td colspan="4">Site Preparation Before Planting (See <i>Special Methods of Weed Control</i> on page 205.)</td></tr>
<tr><td colspan="4">Recommended rates /ha or /ac refer to area actually treated with herbicide.
PREEMERGENCE (PRE) — Rainfall at 15–20 mm within 7–10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.
CAUTION — Simazine, DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of the planting.</td></tr>
<tr><td colspan="4">Blueberries (Highbush) — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)</td></tr>
<tr><td>napropamide
DEVRINOL DF (50 DF)</td><td>4.5 kg/ha
9 L/ha</td><td>3.6 L/ac</td><td>• PRE — Apply once/season, either in the fall or spring, before weeds emerge.
• Incorporation by rainfall or irrigation is essential.
• Do NOT apply to frozen ground.</td></tr>
<tr><td colspan="4">Blueberries (Highbush) — Year of Planting (Postemergence Grass Herbicides)</td></tr>
<tr><td colspan="4">POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.</td></tr>
<tr><td>fluazifop-p-butyl
VENTURE L (125 g/L)</td><td>0.125 to 0.25 kg/ha
1 L to 2 L /ha</td><td>0.48 to 0.8 L/ac</td><td>• Apply to actively growing grasses.
• For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage.
• For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days.
• Do NOT apply closer than 30 days to harvest.</td></tr>
</table>

BLUEBERRIES

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr after application. • **Do NOT** apply closer than 15 days to harvest.
Blueberries (Highbush) — Year of Planting (Postemergence Broadleaf Herbicides)			
clopyralid LONTREL 360 (360 g/L)	0.15 to 0.3 kg/ha 0.42 to 0.83 L/ha	 0.17 to 0.33 L/ac	• Apply once/year, directed under the bushes on emerged weeds. • For emerged vetch, use 0.42 L/ha. • For red and white clover, use 0.83 L/ha. • **Do NOT** apply closer than 45 days to harvest.
Blueberries (Highbush) — Year of Planting (Postemergence Grass & Broadleaf Herbicides)			
glyphosate glyphosate* (360 g/L)	1 to 2 kg/ha 2.8 to 5.6 L/ha	 1.12 to 2.24 L/ac	• Apply as a directed spray under the bushes, avoiding new shoots. • Apply in 200–300 L/ha water (80–120 L/ac), using no more than 275 kPa pressure. • Avoid contact with fruit, foliage or canes. • Use only 1 application/season. • **Do NOT** apply closer than 30 days to harvest.
Blueberries (Highbush) — Established Plantings (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	7 to 9 kg/ha 175 to 225 kg/ha	 70 to 90 kg/ac	• PRE — Apply to cool moist but unfrozen soil in late fall or spring before weeds emerge. • **Do NOT** apply if air temps are above 10°C–15°C to avoid injury from volatilization. • Use the lower rate if irrigation or rain will follow application. • 70 g CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac). • Use **ONLY** under plants established for at least 3 yrs. • **Do NOT** use on light, sandy soil.
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	 3.6 kg/ac	• PRE — Apply once/season, either in the fall or spring, before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply to frozen ground. • **Do NOT** apply within 70 days of harvest.
simazine PRINCEP NINE-T (90 WG) SIMAZINE 80W (80 WP)	2.25 to 3.38 kg/ha 2.5 to 3.75 kg/ha 2.75 to 4.25 kg/ha	 1 to 1.5 kg/ac 1.1 to 1.7 kg/ac	• PRE — Apply in 300–1,000 L/ha water (120–400 L/ac) before weed emergence. • Use lower rates for coarse, sandy soil. • Use higher rates for clay or higher organic matter soil. • Use only on established plants.

BLUEBERRIES

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)
terbacil SINBAR (80 WP)	2.2 to 3.4 kg/ha 2.75 to 4.25 kg/ha	1.1 to 1.7 kg/ac	• PRE — Apply in 200–1,000 L/ha water (80–400 L/ac). • Use only in plantings established in the field for at least 1 year. • Make 1 application/yr. • Injury may occur on sandy soil even with the low rate. • Use the high rate only on muck or peat soils where experience has shown this to be a safe practice.
Blueberries (Highbush) — Established Plantings (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 L to 2 L /ha	0.48 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, use 1 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • **Do NOT** apply closer than 30 days to harvest.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr after application. • **Do NOT** apply closer than 15 days to harvest.
Blueberries (Highbush) — Established Plantings (Postemergence Broadleaf Herbicides)			
bentazon BASAGRAN plus oil concentrate ASSIST	0.84 kg/ha 1.75 L/ha	 0.7 L/ac	• For top growth control of yellow nut sedge. • Make 2 applications 7–10 days apart, when weeds are small. • **Do NOT** apply more than 2 times/year. • **Do NOT** apply closer than 25 days to harvest.
clopyralid LONTREL 360 (360 g/L)	0.15 to 0.3 kg/ha 0.42 to 0.83 L/ha	 0.17 to 0.33 L/ac	• Apply once/year, directed under the bushes on emerged weeds. • For emerged vetch, use 0.42 L/ha. • For red and white clover, use 0.83 L/ha. • Do NOT apply closer than 45 days to harvest.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
Blueberries (Highbush) — Established Plantings (Postemergence Grass & Broadleaf Herbicides)			
glyphosate glyphosate* (360 g/L)	1 to 2 kg/ha 2.8 to 5.6 L/ha	1.12 to 2.24 L/ac	• Apply as a directed spray under the bushes, avoiding new shoots. • Apply in 200–300 L/ha water (80–120 L/ac), using no more than 275 kPa pressure. • Avoid contact with fruit, foliage or canes. • Use only 1 application/season. • **Do NOT** apply closer than 30 days to harvest.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	• Apply in 1,000 L/ha water (400 L/ac). • For spot spraying, apply 55 mL product/10 L water sprayed to wet weed foliage. • Use on plantings established at least 1 year.
paraquat GRAMOXONE (200 g/L) plus simazine PRINCEP NINE-T (90 WG)	1.1 kg/ha 5.5 L/ha 2.25 to 3.38 kg/ha 2.5 to 3.75 kg/ha	2.2 L/ac 1 to 1.5 kg/ac	• For emerged weeds with residual control of germinating weeds. • Apply as a directed spray to established plantings. • Use 1,000 L/ha water (400 L/ac) to wet weed foliage. • Use lower rates for coarse, sandy soil. • Use higher rates for clay or higher organic matter soil.

* Various formulations available, see Table 13-1, *Pesticides Used on Fruit Crops in Ontario*, on page 266.

CRANBERRIES

Maintaining a healthy and vigorous crop will aid in weed control by avoiding openings in the bed for weed germination and establishment.

Prevent weeds from setting seed on dikes and in adjacent uncropped areas by using cultural or chemical weed control measures. Mowing at regular intervals will prevent many weeds from setting seed. Seeding the dikes with a desirable grass cover will reduce the opportunities for weed establishment and will provide bank stabilization.

Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205.)

PREEMERGENCE — Rainfall at 15–20 mm within 7–10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

Cranberries — Soil Applied Grass and Broadleaf Herbicides			
dichlobenil CASORON 4G (4 Gr)	4.4 kg/ha 110 kg/ha	44 kg/ac	• PRE — For annual broadleaf weeds, certain sedges and *Juncus* species. • Apply in early spring prebloom. • Temporary reddening of plants may occur, especially with late spring applications. • **Do NOT** use on new plantings, or on newly sanded beds. • **Do NOT** use on beds recently mowed for vines.
napropamide DEVRINOL 10G (10%)	4.5 to 6.7 kg/ha 45 to 67 kg/ha	18 to 26.8 kg/ac	• PRE — Apply once/year in spring and irrigate immediately. • **Do NOT** use on new beds.

Cranberries — Postemergence Grass Herbicides

POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.

CRANBERRIES

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*****, pg 189 and *****Notes on Adjuvants*****, pg 198)**
fluazifop-p-butyl	0.125 to 0.25 kg/ha		• For non-bearing cranberries. • Apply to actively growing grasses. • For annual grasses, use 1.0 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. • Use **ONLY** one application/season.
VENTURE L (125 g/L)	1 to 2 L/ha	0.4 to 0.8 L/ac	
sethoxydim	0.15 to 0.5 kg/ha		• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr after application. • **Do NOT** apply closer than 15 days to harvest.
POAST ULTRA (450 g/L)	0.32 to 1.1 L/ha	0.13 to 0.45 L/ac	
plus surfactant/solvent			
MERGE	1 to 2 L/ha	0.4 to 0.8 L/ac	
Cranberries — Postemergence Broadleaf Herbicides			
2,4-D 2,4-D AMINE 500 (470 g/L)	0.47 kg/2 L water 1 L/2 L water (33% solution)		• For emerged annual and perennial weeds, including hardhack, St. John's Wort, alder, purple aster. • Apply with a ropewick or other wiper to actively growing weeds (June to July). • **Do NOT** contact the crop. • Use **ONLY** one application/year. • **Do NOT** apply closer than 50 days to harvest.
clopyralid LONTREL 360 (360 g/L)	7.2 g/L water 20 mL/L water (2% solution)		• For emerged vetch. • **Do NOT** use more than 2 applications a year in spring before bud break, again until growth is 1 to 2 mm long, and/or in the fall at least 2 weeks after harvest, when vines have winter dormancy colour. • Apply with wiper equipment onto weed foliage that extends above the cranberry canopy. Avoid contact with cranberry shoots after growth begins. • **Do NOT** apply closer than 60 days to harvest.
Cranberries — Postemergence Grass and Broadleaf Herbicides			
glyphosate* glyphosate (360 g/L)	0.36 kg/4L of water 1 L/4L of water (20% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the cranberry vines. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.

* Various formulations available, see Table 13–1. See label for specific uses and rates.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)

CURRANTS AND GOOSEBERRIES

Cultural Weed Control See *Cultural Weed Control in Berry Crops* on page 239. There are no herbicides registered for preemergence weed control in currants and gooseberries. A biodegradable mulch could be used for weed control in the planting strip. A straw mulch will assist in weed control.

Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205.)

Recommended rates /ha or /ac refer to area actually treated with herbicide.
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Always use appropriate drift management technology.

Currants and Gooseberries — Established Plantings (Postemergence Grass & Broadleaf Herbicides)

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	• Apply in 1,000 L/ha water (400 L/ac). • For spot treatment, apply 55 mL in 10 L of water, sprayed to wet weed foliage. • Direct the spray to wet the weeds but avoid wetting the leaves or green bark of the bushes.

RASPBERRIES

Cultural Weed Control See *Cultural Weed Control in Berry Crops* on page 239.

Site Preparation Before Planting (See Special *Methods of Weed Control* on page 205.)

Recommended rates /ha or /ac refer to area actually treated with herbicide.

PREEMERGENCE — Rainfall at 15–20 mm within 7–10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.
CAUTION: DEVRINOL and SIMAZINE residues, high enough to harm many crops, may persist for several years after removal of a planting.

Raspberries — Year of Planting (Soil Applied Grass & Broadleaf Herbicides)

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 L/ha	3.6 L/ac	• PRE — Apply once/season, either in the fall or spring, before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply to frozen ground. • Avoid contact with fruit or foliage.

Raspberries — Year of Planting (Postemergence Grass Herbicides)

POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Always use appropriate drift management technology.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS
fluazifop-p-butyl VENTURE L (125 g/L)	0.15 to 0.25 kg/ha 1.2 to 2 L/ha	0.48 to 0.8 L/ac	• Apply in early spring at prebloom stage to actively growing grasses. • For annual grasses, use 1.2 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • **Do NOT** apply closer than 30 days to harvest.

RASPBERRIES

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Raspberries — Year of Planting (Postemergence Broadleaf Herbicides)			
2,4-D * 2,4-D (470 g/L)	0.55 kg/ha 1.2 L/ha	 0.48 L/ac	• Use the amine formulation. • Apply in 100–200 L/ha water (40–80 L/ac). • **Do NOT** spray when plants are in bloom. • Keep spray off new shoots as much as possible. • Spot spraying at a rate equivalent to 1 kg ai/ha (0.4 kg ai/ac) may be necessary to control established dandelions and other broadleaf weeds.
Raspberries —Year of Planting (Postemergence Grass & Broadleaf Herbicides)			
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	 2.2 L/ac	• Apply in 1,000 L/ha water (400 L/ac). • For spot spraying, apply 55 mL GRAMOXONE/10 L water sprayed to wet weed foliage. • Direct spray at base of canes in the spring before new shoots emerge.
Raspberries — Established Plantings (Soil Applied Grass & Broadleaf Herbicides)			
dichlobenil CASORON 4G (4 Gr)	7 kg/ha 175 kg/ha	 70 kg/ac	• PRE — Apply on established raspberry plantings in late fall. • Apply to cool moist but unfrozen soil before weeds emerge. • **Do NOT** apply if air temps are above 10°C–15°C to avoid injury from volatilization. • 70 g CASORON 4G applied to an area 2x2 m is equivalent to 175 kg/ha (70 kg/ac). • **Do NOT** use on light, sandy soil. • **Do NOT** cultivate or work into the soil. • **Do NOT apply in the spring** as injury may result.
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	 3.6 kg/ac	• PRE — Apply once/season, either in the fall or spring, before weeds emerge. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply to frozen ground. • Avoid contact with fruit or foliage.
simazine PRINCEP NINE-T (90 WG) SIMADEX (500 g/L) SIMAZINE 480 (480 g/L)	1.8 to 2.25 kg/ha 2 to 2.5 kg/ha 3.6 to 4.5 L/ha 3.8 to 4.7 L/ha	 0.8 to 1 kg/ac 1.44 to 1.8 L/ac 1.52 to 1.88 L/ac	• PRE — Apply in 300–1,000 L/ha water (120–400 L/ac) before weed emergence. • Apply as a directed spray early in the spring before the weeds emerge. • Use lower rates for coarse, sandy soil. • Use higher rates for clay or higher organic matter soil. • Keep spray off young shoots. • **Do NOT** use in first year plantings.
Raspberries — Established Plantings (Postemergence Grass Herbicides)			

POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Adjuvants will frequently improve the weed control when used as directed. Weather or other conditions may influence the optimum rate of adjuvant, see the product label for more details. Always use appropriate drift management technology.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, **pg 189 and *Notes on Adjuvants*, pg 198)**
fluazifop-p-butyl VENTURE L (125 g/L)	0.15 to 0.25 kg/ha 1.2 to 2 L/ha	0.48 to 0.8 L/ac	• Apply in early spring at prebloom stage to actively growing grasses. • For annual grasses, use 1.2 L/ha. Apply at the 2–6 leaf stage. • For quackgrass, use 2 L/ha. Apply at the 3–5 leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • **Do NOT** apply closer than 30 days to harvest.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr. after application. • **Do NOT** apply closer than 37 days to harvest.
Raspberries — Established Plantings (Postemergence Broadleaf Herbicides)			
2,4-D * 2,4-D (470 g/L)	0.55 kg/ha 1.2 L/ha	0.48 L/ac	• Use the amine formulation. • Apply in 100–200 L/ha water (40–80 L/ac) actually sprayed. • **Do NOT** spray when plants are in bloom. • Keep spray off new shoots as much as possible. • Spot spraying at a rate equivalent to 1 kg ai/ha (0.4 kg ai/ac) may be necessary to control established dandelions and other broadleaf weeds.
Raspberries — Established Plantings (Postemergence Grass & Broadleaf Herbicides)			
glufosinate ammonium IGNITE (150 g/L)	1 kg/ha 6.67 L/ha	2.7 L/ac	• For use in the production year of raspberries grown in the biennial production system, or in a planting that will be removed after harvest. • **Do NOT** apply to immature and weak plantings. • Apply when shoots are 10–20 cm tall to suppress the emerged flush of primocanes, and control any weeds emerged at time of treatment. • Apply in a minimum of 330 L water/ha (132 L/ac). • Avoid drift onto green tissue of floricanes.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	• Apply in 1,000 L/ha water (400 L/ac). • For spot spraying, apply 55 mL GRAMOXONE/10L water sprayed to wet weed foliage. • Direct spray at base of canes in the spring before new shoots emerge.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
paraquat	1.1 kg/ha		• For emerged weeds with residual control of germinating weeds. • Apply as a directed spray to established plantings. • Do NOT spray young raspberry shoots. • Use 1,000 L/ha water (400 L/ac) to wet weed foliage. • Use lower rates for coarse, sandy soil. • Use higher rates for clay or higher organic matter soil.
GRAMOXONE (200 g/L)	5.5 L/ha	2.2 L/ac	
plus simazine	1.8 to 2.25 kg/ha		
PRINCEP NINE-T (90 WG)	2 to 2.5 kg/ha	0.8 to 1 kg/ac	

* Various formulations are available, see Table 13-1, *Pesticides Used on Fruit Crops in Ontario*, on page 266. See label for specific uses and rates.

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Strawberries — First (Planting) Year

Cultural Weed Control See *Cultural Weed Control in Berry Crops* on page 239.

Use straw mulch that is free of weed seeds to avoid importing weeds into the field. Spread mulch between the rows when it is pulled off the plants in the spring to provide additional weed control.

Site Preparation Before Planting (See *Special Methods of Weed Control* on page 205.)

Recommended rates /ha or /ac refer to area actually treated with herbicide.

PREEMERGENCE — Rainfall at 15–20 mm within 7–10 days after application is necessary to activate preemergence treatments. Shallow cultivation, or harrowing will control weed escapes and improve herbicide activity in the absence of rainfall.

CAUTION: DEVRINOL and SINBAR residues, high enough to harm many crops, may persist for several years after removal of a planting.

Strawberries — First (Planting) Year — Before Planting (Soil Applied Grass and Broadleaf Herbicides)

metolachlor	1.14 to 1.6 kg/ha		• PPI or PRE — Apply and incorporate, or apply post-transplanting before weeds emerge. • Apply **ONLY** once/year. • Apply by ground application equipment **ONLY**. • **Do NOT** apply to cultivar Joliette. • **Do NOT** harvest berries from varieties bearing fruit in year of planting.
DUAL MAGNUM (915 g/L)	1.25 to 1.75 L/ha	0.5 to 0.7 L/ac	
trifluralin	0.6 to 1.155 kg/ha		• PPI — Apply to weed free soil and incorporate immediately in 2 directions. • May be applied and incorporated 1 day to 3 weeks before planting. • May delay establishment under stressful conditions.
TREFLAN EC (480 g/L)	1.25 to 2.4 L/ha	0.5 to 0.96 L/ac	
RIVAL EC (500 g/L)	1.2 to 2.2 L/ha	0.48 to 0.94 L/ac	
BONANZA 400 (400 g/L)	1.5 to 2.75 L/ha	0.6 to 1.1 L/ac	

Strawberries — First (Planting) Year — 2 to 4 Weeks After Planting (Soil Applied Grass and Broadleaf Herbicides)

napropamide	4.5 kg/ha		• PRE — Apply once/season before weeds emerge or following a cultivation. • Incorporation by rainfall, irrigation or cultivation is essential. • Where daughter plant establishment is important, (e.g., for plant producers) delay application until desired number of daughter plants have been established. • Inhibition of daughter plant roots can occur where soil moisture is low and will be minimized if irrigation is applied shortly after application.
DEVRINOL DF (50 DF)	9 kg/ha	3.6 kg/ac	

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Strawberries — First (Planting) Year — 2 to 4 Weeks After Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 to 2 L/ha	0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, apply 1 L/ha at the 25 leaf stage of growth. • For quackgrass, apply 2 L/ha at the 3–5 leaf stage of growth. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • Use only 1 application/season. • Wait at least 14 days after application before applying SINBAR.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr. after application. • **Do NOT** apply closer than 25 days to harvest. • Wait at least 14 days after application before applying SINBAR.
Strawberries — First (Planting) Year — 2 to 4 Weeks After Planting (Postemergence Broadleaf Herbicides)			
2,4D * 2,4-D (470 g/L)	0.55 kg/ha 1.17 L/ha	0.47 L/ac	• Use the amine formulation. • Apply in 100–200 L/ha of water (40–80 L/ac). • Use low pressure and a coarse spray to minimize risk of spray drift to susceptible crops. • **Do NOT** use while early runners are rooting. • **Do NOT** use between mid-August and fall dormancy when flower buds are developing for next year's crop.
Strawberries — First (Planting) Year — 2 to 4 Weeks After Planting (Postemergence Grass and Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the strawberry plants. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers as a spot treatment if wiper equipment is not available. • Avoid contact with strawberry plant: crop in the treated area will be killed. • **Do NOT** apply closer than 30 days before harvest.

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Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, pg 189 and ***Notes on Adjuvants***, pg 198)
Strawberries — First (Planting) Year — 4 to 6 Weeks After Planting (Soil Applied Grass and Broadleaf Herbicides)			
terbacil SINBAR (80 WP)	0.22 to 0.44 kg/ha 0.28 to 0.55 kg/ha	0.11 to 0.22 kg/ac	• PRE — Apply before weeds emerge or to very small weeds. • Apply when mother plants are well established but before runnering becomes extensive and new runner plants are rooting. • Apply in at least 300 L/ha water (120 L/ac). • Use lower rate on sandy soils low in organic matter. • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately. • Shallow cultivation can be done to train runners and control escaped weeds without destroying the effectiveness of SINBAR.
Strawberries — First (Planting) Year — 4 to 6 Weeks After Planting (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 to 2 L/ha	0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, apply 1 L/ha at the 2–5 leaf stage of growth. • For quackgrass, apply 2 L/ha at the 3–5 leaf stage of growth. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • Use **ONLY** 1 application/season. • Wait at least 14 days after application before applying SINBAR.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • Do NOT use flood jet or hollow cone nozzles. • Do NOT apply if rain is expected within 1 hr after application. • Wait at least 14 days after application before applying SINBAR. • Do NOT apply closer than 25 days to harvest.

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Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)
Strawberries — First (Planting) Year — 4 to 6 Weeks After Planting (Postemergence Broadleaf Herbicides)			
2,4-D * 2,4-D (470 g/L)	0.55 kg/ha 1.17 L/ha	0.47 L/ac	• Use the amine formulation. • Apply in 100–200 L/ha of water (40–80 L/ac). • Use low pressure and a coarse spray to minimize risk of spray drift to susceptible crops. • **Do NOT** use while early runners are rooting. • **Do NOT** use between mid-August and fall dormancy when flower buds are developing for next year's crop.
Strawberries — First (Planting) Year — 4 to 6 Weeks After Planting (Postemergence Grass and Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the strawberry plants. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers for a spot treatment if wiper equipment is not available. • Avoid contact with strawberry plant crop in the treated area will be killed. • **Do NOT** apply closer than 30 days before harvest.
Strawberries — First (Planting) Year — Late Summer/Fall (Labour Day) (Soil Applied Grass & Broadleaf Herbicides)			
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	• PRE — Apply before weeds emerge or following a cultivation. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply during harvest period. • **Do NOT** apply more than once/season.
terbacil SINBAR (80 WP)	0.144 to 0.22 kg/ha 0.18 to 0.28 kg/ha	0.07 to 0.11 kg/ac	• PRE — Important timing for fall germinating weeds. Apply before weeds emerge or to very small weeds. • Apply in at least 300 L/ha water (120 L/ac). • Use lower rate on sandy soils low in organic matter • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately. • Shallow cultivation can be done to train runners and control escaped weeds without destroying the effectiveness of SINBAR.
Strawberries — First (Planting) Year — Late Summer/Fall (Labour Day) (Postemergence Grass Herbicides)			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 to 2 L/ha	0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, apply 1 L/ha at the 2–5 leaf stage of growth. • For quackgrass, apply 2 L/ha at the 3–5 leaf stage of growth. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • Use **ONLY** one application/season. • Wait at least 14 days after application before applying SINBAR.

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Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
sethoxydim	0.15 to 0.5 kg/ha		• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr. after application. • Wait at least 14 days after application before applying SINBAR. • **Do NOT** apply closer than 25 days to harvest.
POAST ULTRA (450 g/L)	0.32 to 1.1 L/ha	0.13 to 0.45 L/ac	
plus surfactant/solvent MERGE	1 to 2 L/ha	0.4 to 0.8 L/ac	
Strawberries — First (Planting) Year — Late Summer/Fall (Labour Day) (Postemergence Grass & Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the strawberry plants. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers for a spot treatment if wiper equipment is not available. • Avoid contact with strawberry plant crop in the treated area will be killed. • **Do NOT** apply closer than 30 days before harvest.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	• Apply to narrow strawberry rows and remove weeds between the rows. • Apply in 550–1,100 L/ha water (220–440 L/ac). • Apply on a calm day. • Use shields with low pressure and a spray nozzle arrangement to avoid drift. • Complete coverage is important. Use higher water volumes on dense vegetation. • Perennial weeds will only be suppressed. • Only emerged weeds will be controlled.
Strawberries — First (Planting) Year — Late Fall (Soil Applied Grass and Broadleaf Herbicides)			
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	• PRE — Apply to a weed free soil surface just before mulching, but not on frozen ground. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply more than once/season.

Active Ingredient **TRADE NAME (Formulation**	**RATE (active)** **PRODUCT/HA**	**RATE PRODUCT PER ACRE**	**PRECAUTIONS** **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
terbacil SINBAR (80 WP)	0.56 to 0.68 kg/ha 0.7 to 0.85 kg/ha	0.28 to 0.34 kg/ac	• PRE — Apply to a weed free soil surface just before mulching. • Apply in at least 300 L/ha water (120 L/ac). • Use low rate where it is planned to use SINBAR again in the spring. • Use lower rate on sandy soils low in organic matter. • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately.
Strawberries — Harvesting Year			
Strawberries — Harvesting Year — Spring After Mulch Removal (Soil Applied Grass and Broadleaf Herbicides)			
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	• PRE — Apply to weed free soil just after mulch is removed, but not on frozen ground. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply from bloom to harvest. • **Do NOT** apply more than once/season.
terbacil SINBAR (80 WP)	0.22 to 0.28 kg/ha 0.28 to 0.35 kg/ha	0.11 to 0.14 kg/ac	• PRE — Apply to weed free soil just after mulch is removed. • Apply in at least 300 L/ha water (120 L/ac). • If strawberry plants have made weak yellow growth under the mulch, wait 5–7 days until plants recover before applying SINBAR. • Use low rate where SINBAR was used in the fall. • Use lower rate on sandy soils low in organic matter. • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately.
Strawberries — Harvesting Year — Spring After Mulch Removal (Postemergence Grass Herbicides)			
POSTEMERGENCE — Leaf stage of the weeds is critical for good weed control. Smaller weeds are generally easier to kill but there needs to be enough leaf surface to intercept the herbicide. Apply according to recommended leaf stages. Crop stage is important to optimize crop safety. Always use appropriate drift management technology.			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 to 2 L/ha	0.4 to 0.8 L/ac	• Apply before bloom to actively growing grasses. • For annual grasses, apply 1 L/ha at the 2–5 leaf stage of growth. • For quackgrass, apply 2 L/ha at the 3–5 leaf stage of growth. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • Use only 1 application/season. • Wait at least 14 days after application before applying SINBAR. • **Do NOT** apply closer than 30 days to harvest.

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Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS **(For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)**
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100 to 200 L water/ha (40 to 80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr after application. • Wait at least 14 days after application before applying SINBAR. • **Do NOT** apply closer than 25 days to harvest.
Strawberries — Harvesting Year — Spring After Mulch Removal (Postemergence Grass and Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the strawberry plants. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers for a spot treatment if wiper equipment is not available. • Avoid contact with strawberry plant crop in the treated area will be killed. • **Do NOT** apply closer than 30 days before harvest.
Strawberries — Harvesting Year — Renovation (Soil Applied Grass and Broadleaf Herbicides)			
terbacil SINBAR (80 WP)	0.56 to 0.68 kg/ha 0.7 to 0.85 kg/ha	 0.28 to 0.34 kg/ac	• PRE — Apply after mowing before weeds emerge or to very small weeds. • Apply in at least 300 L/ha water (120 L/ac). • If, 2,4-D was used prior to mowing, delay applying SINBAR for at least 2 weeks. • **Do NOT** apply within 14 days of VENTURE L. • Use lower rate on sandy soils low in organic matter. • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately. • Shallow cultivation can be done to train runners and control escaped weeds without destroying the effectiveness of SINBAR.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops***, **pg 189 and** ***Notes on Adjuvants***, **pg 198)**
Strawberries — Harvesting Year — Renovation (Postemergence Grass Herbicides)			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 to 2 L/ha	0.4 to 0.8 L/ac	• Apply before mowing to actively growing grasses. • For annual grasses, apply 1 L/ha at the 2–5 leaf stage of growth. May not control foxtail. • For quackgrass, apply 2 L/ha at the 3–5 leaf stage of growth. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • Use **ONLY** one application/season. • Wait at least 14 days after application before applying SINBAR.
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • Do NOT use flood jet or hollow cone nozzles. • Do NOT apply if rain is expected within 1 hr after application. • Wait at least 14 days after application before applying SINBAR. • Do NOT apply closer than 25 days to harvest.
Strawberries — Harvesting Year — Renovation (Postemergence Broadleaf Herbicides)			
2,4-D * 2,4-D (470 g/L)	1.034 kg/ha 2.2 L/ha	0.88 L/ac	• Apply after harvest but before mowing to control dandelions and other broadleaf perennials. Delay mowing for a few days after application. • Use amine formulation. • **Do NOT** apply 2,4-D between mid August and fall dormancy when strawberries are initiating flower buds. • Some cultivars like Veestar are more sensitive to 2,4-D than Redcoat.
clopyralid LONTREL 360 (360 g/L)	0.2 to 0.3 kg/ha 0.56 to 0.83 L/ha	0.22 to 0.33 L/ac	• To control tufted vetch, Canada thistle, sheep sorrel and ox-eye daisy. • Apply immediately after harvest at renovation, 7–10 days before mowing. • Apply with a boom sprayer in 150–250 L/ha of water (60–100 L/ac). • Apply once/year as a single treatment. • Early cultivars like Veestar or Annapolis may be more susceptible to injury. • Certain environment stresses such as drought, flooding or severe overwintering conditions may increase the risk of injury. • **Do NOT** apply closer than 200 days to harvest.
Strawberries — Harvesting Year — Renovation (Postemergence Grass and Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the strawberry plants. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.

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Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers for a spot treatment if wiper equipment is not available. • Avoid contact with strawberry plant crop in the treated area will be killed. • **Do NOT** apply closer than 30 days before harvest.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	2.2 L/ac	• Apply just after harvest to narrow rows and remove weeds between the rows. • Repeat application in the early fall (Labour Day) if required. • Apply in 550–1,100 L/ha water (220–440 L/ac). • Apply on a calm day. • Use shields with low pressure and a spray nozzle arrangement to avoid drift. • Complete coverage is important. Use higher water volumes on dense vegetation. • Perennial weeds will only be suppressed. • Only emerged weeds will be controlled.
Strawberries — Harvesting Year— Late Summer/Fall (Labour Day) (Soil Applied Grass & Broadleaf Herbicides)			
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	• PRE — Apply before weeds emerge or following a cultivation. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply during harvest period. • **Do NOT** apply more than once/season.
terbacil SINBAR (80 WP)	0.144 to 0.22 kg/ha 0.18 to 0.28 kg/ha	0.07 to 0.11 kg/ac	• PRE — Important timing for fall germinating weeds. Apply before weeds emerge or to very small weeds. • Apply in at least 300 L/ha water (120 L/ac). • Use lower rate on sandy soils low in organic matter. • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately. • Shallow cultivation can be done to train runners and control escaped weeds without destroying the effectiveness of SINBAR.
Strawberries — Harvesting Year — Late Summer/Fall (Labour Day) (Postemergence Grass Herbicides)			
fluazifop-p-butyl VENTURE L (125 g/L)	0.125 to 0.25 kg/ha 1 to 2 L/ha	0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grasses, apply 1 L/ha at the 2–5 leaf stage of growth. • For quackgrass, apply 2 L/ha at the 3–5 leaf stage of growth. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. • Use **ONLY** one application/season. • Wait at least 14 days after application before applying SINBAR.

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see ***Herbicides for Fruit Crops*****, pg 189 and *****Notes on Adjuvants*****, pg 198)**
sethoxydim POAST ULTRA (450 g/L) plus surfactant/solvent MERGE	0.15 to 0.5 kg/ha 0.32 to 1.1 L/ha 1 to 2 L/ha	 0.13 to 0.45 L/ac 0.4 to 0.8 L/ac	• Apply to actively growing grasses. • For annual grass, use 0.32 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For volunteer grains, use 0.47 L/ha. Apply at the 1–6 leaf stage (2–5 is optimum). • For quackgrass, use 1.1 L/ha. Apply up to the 3–leaf stage. Thorough preplant tillage will ensure more uniform quackgrass emergence. Cultivate after 7 days. Use the high rate of MERGE for quackgrass. • Use 100–200 L water/ha (40–80 L water/ac). • Grasses emerging after application will not be controlled. • Spray tips angled forward 45° will give better coverage. • **Do NOT** use flood jet or hollow cone nozzles. • **Do NOT** apply if rain is expected within 1 hr after application. • Wait at least 14 days after application before applying SINBAR. • **Do NOT** apply closer than 25 days to harvest.
Strawberries — Harvesting Year — Late Summer/Fall (Labour Day) (Postemergence Grass & Broadleaf Herbicides)			
glyphosate* glyphosate (360 g/L)	0.36 kg/2 L 1 L/2 L water (33% solution)		• Apply with a rope wick or other similar device when weeds are 15 cm above the crop. • Avoid contact with the strawberry plants. • **Do NOT** apply when weeds are wet. • See *Wiper Applicators for Selective Weed Control* on page 14.
glyphosate* glyphosate (360 g/L)	0.36 to 0.72 kg/100 L 1 to 2 L/100 L water (1 to 2% solution)		• Use hand held sprayers for a spot treatment if wiper equipment is not available. • Avoid contact with strawberry plant crop in the treated area will be killed. • **Do NOT** apply closer than 30 days before harvest.
paraquat GRAMOXONE (200 g/L)	1.1 kg/ha 5.5 L/ha	 2.2 L/ac	• Apply to narrow rows and remove weeds between the rows. • Apply in 550–1,100 L/ha water (220–440 L/ac). • Apply on a calm day. • Use shields with low pressure and a spray nozzle arrangement to avoid drift. • Complete coverage is important. Use higher water volumes on dense vegetation. • Perennial weeds will only be suppressed. • Only emerged weeds will be controlled.

STRAWBERRIES

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT/HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see *Herbicides for Fruit Crops*, pg 189 and *Notes on Adjuvants*, pg 198)
Strawberries — Harvesting Year — Late Fall (Soil Applied Grass and Broadleaf Herbicides)			
napropamide DEVRINOL DF (50 DF)	4.5 kg/ha 9 kg/ha	3.6 kg/ac	• PRE — Apply to a weed free soil surface just before mulching, but not on frozen ground. • Incorporation by rainfall or irrigation is essential. • **Do NOT** apply more than once/season.
terbacil SINBAR (80 WP)	0.56 to 0.68 kg/ha 0.7 to 0.85 kg/ha	0.28 to 0.34 kg/ac	• PRE — Apply to a weed free soil surface just before mulching. • Apply in at least 300 L/ha water (120 L/ac). • Use low rate where it is planned to use SINBAR again in the spring. • Use lower rate on sandy soils low in organic matter. • Use lower rate on sensitive varieties such as Kent, Bounty, Micmac, Annapolis, Glooscap and Cavendish since they may be severely injured. • **Do NOT** apply to weak or diseased plants of any variety. • **Do NOT** overlap spray swaths. Calibrate sprayer accurately.

* Various formulations are available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266. See label for specific uses and rates.

Strawberry Herbicide Weed Control Ratings

Notes

Weed control ratings are given as 0–9 where 0 indicates no control and 9 indicates 90%–100% control under ideal conditions.

Ratings are subjective values based on best available information and give general comparisons based on use as described in this guide.

Under unfavorable conditions (e.g., too dry, too wet, too cold, or poor application) the herbicides may not be as effective as indicated.

Ratings may vary with weed and crop stage and with the timing and rates of the product(s) being used. Ratings in **BOLD** indicate the weed is listed on the product label for control or suppression. Please see product label for more information on registered weed species, product uses and precautions.

TABLE 12–7. Strawberry Herbicide Weed Control Ratings

TRADE NAME	annual grasses						annual broadleaves									perennial weeds																	
	barnyard grass	crabgrass	fall panicum	foxtails	old witch grass	volunteer grains	chickweed, common	groundsel	lady's-thumb	lamb's-quarters	mustards	pigweeds	ragweed	snapdragon, dwarf	violet, field (field pansy)	bindweeds	brome grass	chickweed, mouse-eared	daisy, ox-eye	dandelion	ground-ivy (creeping charlie)	mallow	milkweed	nutsedge	plantains	poison-ivy	quackgrass	sorrel, sheep	sow-thistle	thistle, Canada	toadflax, yellow	vetches
soil applied grass and broadleaf herbicides																																	
BONANZA, TREFLAN, RIVAL	8	9	8	9	8	9	8	3	7	8	3	8	4	?	?	0	?	5	0	0	0	0	0	9	0	0	0	0	0	0	0	0
DEVRINOL	8	9	8	8	8	8	8	8	6	8	5	8	6	0	0	8	8	?	?	2	?	?	5	5	2	?	5	0	5	5	?	0
DUAL MAGNUM	9	9	9	9	9	?	?	?	2	7	2	7/8	4	?	?	0	?	?	?	5	?	?	0	8	5	?	4	?	0	0	?	0
SINBAR	8	7	8	8	8	8	8[a]	5	7[a]	8[a]	8[a]	7[a]	7[a]	2	5[a]	?	8	?	2	5	?	?	6	6	8	?	6	8	5	6	2	2
postemergence grass herbicide																																	
VENTURE L	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0
POAST + MERGE	9	8	9	9	9	9	0	0	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
postemergence broadleaf herbicide																																	
2,4-D*	0	0	0	0	0	0	7	2	6	8	9	7	8	2	2	2	0	2	2	8	2	0	0	0	8	?	0	8	6	8	?	5
LONTREL 360	0	0	0	0	0	0	0	8	?	5	?	5	9	?	?	0	0	0	8	8	0	0	0	0	0	0	0	9	8[b]	9	0	9
postemergence grass and broadleaf herbicide																																	
GRAMOXONE	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]	8[b]
CREDIT, GLYPHOS, ROUNDUP, TOUCHDOWN, VANTAGE [1]	9	9	9	9	9	9	9	8	9	8	9	9	8	?	?	7/8	9	9	?	8	5	5	9	8	9	9	8	8	9	9	8	5[a]

* Various products are available, see Table 13–1, *Pesticides Used on Fruit Crops in Ontario*, on page 266. ? Insufficient information available to make a rating.

[1] Spot treatment only [a] Low rates and single applications may provide less control. [b] Top growth only; regrowth can be expected. Repeated treatments may provide control.

WATER WEEDS (AQUATIC PLANTS)

The *Pesticides Act*, Subsection 5(1), provides that: "*no person shall engage in, perform, or offer to perform an extermination except under and in accordance with a licence of a prescribed class...unless exempt under the regulations*".

Therefore, a specific water exterminator's licence is required by anyone applying a pesticide to water in Ontario (unless exempt). For instance, the user of a herbicide to control aquatic plants in Ontario requires an Aquatic Vegetation licence. The licensing system ensures that people are educated about the proper storage, handling, and use of pesticides, and their impact on the environment. Furthermore, if the person is in the business of performing exterminations, an Operator's Licence is also required.

A person is exempt from holding an Aquatic Vegetation licence if using a pesticide to treat a water body for aquatic plants and the water body is located wholly within the boundaries of their property. The water body must have **no** direct or indirect outflow, other than by percolation. A full-time employee of the property owner is also exempt from requiring a licence.

Subsection 7(2) of the *Pesticides Act* provides that: "*no person shall perform a water extermination unless the person is the holder of a permit issued by the Director* [under the *Pesticides Act*] *for the water extermination or is exempt under the regulations*".

Therefore, unless exempt, a **Permit to Purchase a Pesticide and/or Perform a Water Extermination** must be obtained before any aquatic pesticide can be legally purchased or applied into a water body (e.g. ponds, lakes, rivers, ditches, lagoons, catch basins etc.) in Ontario, unless exempt under the regulations. Exemptions include:

- A property owner or their full-time employee is not required to obtain a permit to use an aquatic herbicide in a water body, which has no direct or indirect outflow, other than by percolation, located wholly within the boundaries of his or her own property, or an aquatic herbicide in a drainage ditch that at the time of the extermination contains no moving water but must hold a permit in order to purchase the pesticide.

- A person certified through the Grower Pesticide Safety Course is not required to obtain a permit to purchase or to use an aquatic herbicide in a water body, which has no direct or indirect outflow, other than by percolation, located wholly within the boundaries of his or her own farmland, or an aquatic herbicide in a drainage ditch located wholly within the boundaries of his or her own farmland that at the time of the extermination contains no moving water.

- An Aquatic Vegetation licence holder does **not** require a permit to purchase or to use a pesticide to control aquatic plants in a water body, which has no direct or indirect outflow, other than by percolation, located wholly within the boundaries of his or her own property or to use an aquatic herbicide in a drainage ditch that at the time of the extermination contains no moving water.

A Limited vendor can sell a Schedule 3, 4 or 6 pesticide to a person who is exempt from holding a licence and/or a permit. A person must hold either an Aquatic Vegetation licence, a Grower Pesticide Safety Course Certificate or a permit to purchase a Schedule 2 product from a general vendor.

For further information on licensing and permits, contact the Ontario Ministry of the Environment Regional Office in your area (Appendix C). See also Chapter 1, *Using Pesticides Safely*, page 1.

AQUATIC PLANTS

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT PER HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see Herbicides for Fruit Crops, pg 189 and Notes on Adjuvants, pg 198)
Algae and Vascular Submergents (e.g., *Chara*, Canada Water Weed, Tapegrass, Coontail, Water milfoil, Bladderwort, Pondweed			
diquat (aquatic) REWARD (240 g/L)	4.4 to 7 kg/ha 18.3 to 29.2 L/ha	7.4 to 11.8 L/ac	• Mixed submerged vascular plants in ponds, ditches, lakes, river canals, slow moving or still water. Tape grass and *Chara* are not controlled. • **Do NOT** use treated water for animal consumption or swimming for at least 24 hours. • **Do NOT** use for human consumption or irrigation for at least 5 days. • To avoid oxygen depletion, treat only 1/4 to 1/3 of the area at a time. • Rate depends on water depth: • less than 1.5 m — use 18.3 L/ha (7.4 L/ac). • more than 1.5 m — use 25 to 29.2 L/ha (10.1 to 11.8 L/ac). • Apply at dusk in mid-late June when plants are young and growing vigorously.
diquat(aquatic) REWARD (240 g/L)	2.2 kg/ha 9.2 L/ha	3.7 L/ac	• Eurasian water milfoil in lakes. • Treat when plants are in the very early stage of growth (June). • See REWARD note above.
Diuron KARMEX DF 80%	0.5 to 2 ppm diuron or 6.25 kg/ha m to 25 kg/ha m		• Apply lower rates for algae, including filamentous algae such as *Chara*, control and higher rates for Bladderwort and Pondweed. • Apply early in season to surface of water using min. 450 L/ha of water and agitate. Calculate ha m = surface area in sq. m X depth in m/10,000. • Treat only a small portion of the pond at one time to avoid oxygen depletion and fish suffocation. • **Do NOT** use in domestic water supplies or water bodies producing fish for human consumption • **Do NOT** irrigate with treated water for one year. • **Do NOT** apply to ponds or irrigation ditches having desirable trees or plants on the perimeter or to areas where their roots may extend, or in locations where the herbicide may be washed or moved in contact with the roots. • **Do NOT** drain ponds into areas containing desirable plants. • Not effective in flowing water.
2,4-D (aquatic) AQUA-KLEEN (19% by wt)	110-225 kg/ha	44-90 L/ac	• Milfoil, Stargrass, Bladderwort, Eelgrass and Coontail. • Do not use within 1 km of any active water intake. • Do not use water from treated area for consumption by humans or livestock or for irrigation of 2,4-D sensitive crops, for at least 60 days after treatment in confined waterbodies. • Treat early in season when plant growth is sparse to avoid oxygen depletion and fish suffocation.
water soluble dyes AQUASHADE (26%)	195 mL/1,000 m^3 750 mL/1,000 m^3		• Filamentous algae, pond scums. For use in ponds with no outflow. • **Do NOT** apply to water that will be used for drinking or other domestic purposes. • Make application early in the growing season before algae and weed growth develop. Re-apply when the colour of water fades or first new algae growth develops. • Mechanically remove any heavy vegetation before applying AQUASHADE to avoid oxygen depletion and fish suffocation.

AQUATIC PLANTS

Active Ingredient TRADE NAME (Formulation	RATE (active) PRODUCT PER HA	RATE PRODUCT PER ACRE	PRECAUTIONS (For more information see Herbicides for Fruit Crops, pg 189 and Notes on Adjuvants, pg 198)
Emergents (e.g, Duckweed, Water shield, Water lily, Bulrush, Cattail)			
amitrole AMITROL 240 (231 g/L)	9 to 11 kg/ha 37.5 to 45.75 L/ha	15 to 18.3 L/ac	• Cattails in non-crop areas (roadsides, fencerows, ditch banks, drainage ditches). • After catkins are fully formed and up to frost. • **Do NOT** disturb sprayed plant. • **Do NOT** apply where water will be used for irrigation, drinking or other domestic uses. • **Do NOT** apply where water is not wholly confined to user's property. • Apply at a spray volume of 1,000 L/ha (400 L/ac) water.
2,4-D (aquatic) AQUA-KLEEN (19% by wt)	110-225 kg/ha	44-90 L/ac	• For Water lily and Water shield, use 175–225 kg/ha. • **Do NOT** use within 1 km of any active water intake. • **Do NOT** use water from treated area for consumption by humans or livestock or for irrigation of 2,4-D sensitive crops, for at least 60 days after treatment in confined waterbodies. • Treat early in season when plant growth is sparse to avoid oxygen depletion and fish suffocation.
Diuron KARMEX DF (80%)	0.5 to 2 ppm diuron or 6.25 kg/ha m to 25 kg/ha m		• Apply higher rates for emergents such as Duckweed. • Apply early in season to surface of water using min. 450 L/ha of water and agitate. Calculate ha m = surface area in sq. m × depth in m/10,000. • Treat only a small portion of the pond at one time to avoid oxygen depletion and fish suffocation. • **Do NOT** use in domestic water supplies or water bodies producing fish for human consumption. • **Do NOT** irrigate with treated water for one year. • **Do NOT** apply to ponds or irrigation ditches having desirable trees or plants on the perimeter or to areas where their roots may extend, or in locations where the herbicide may be washed or moved in contact with the roots. • **Do NOT** drain ponds into areas containing desirable plants. • Not effective in flowing water.
diquat(aquatic) REWARD (240 /L)	4.4 to 7 kg/ha 18.3 to 29.2 L/ha	7.4 to 11.8 L/ac	• For Duckweed. • Apply by directed surface spray on foliage. • Rate depends on water depth: • less than 1.5 m — use 18.3 L/ha (7.4 L/ac). • more than 1.5 m — use 25 to 29.2 L/ha (10.1 to 11.8 L/ac). • Use in 1700 to 2200 L/ha (680 to 880 L/ac) water. • See REWARD note in previous section.
paraquat GRAMOXONE (200 g/L)	1.1 to 2.2 kg/ha 5.5 to 11 L/ha	2.2 to 4.4 L/ac	• For Cattails, bulrushes and emerged grasses. • **Do NOT** use treated water for 7 days for swimming, human or animal consumption. • **Do NOT** use for irrigation for 5 days. • **Do NOT** apply to muddy water or agitate water excessively for 1 to 2 days after treatment. • Treat cattails and bulrushes when plants are in flower. • Avoid inhalation of spray mist; consult label for appropriate protective clothing. • Apply at a spray volume of 850 to 1000 L/ha (340 to 400 L/ac) water.

Herbicides provide temporary control of nuisance aquatic vegetation. Alternate methods such as mechanical removal (Submergents), dredging or substrate alteration (drainage ditches) can provide longer term control. Management techniques for vegetation control in ponds include minimizing nutrient input, dredging excess sediment, logs and other organic debris, decreasing the surface to depth ratio and increasing the rate of pond turnover (flushing). Some aquatic plant and algae life should be accepted and tolerated as a vital component of a healthy ecosystem.

The use of herbicides may be complicated by the use of water by livestock or humans or by the presence of fish. If the water is flowing, the effect of the chemical on plant, animal, or fish life downstream must be considered. Flowing water, by diluting the herbicide, makes control less effective.

Emergent species such as cattails and bulrushes may have to be sprayed for 2 or 3 consecutive years to bring them under complete control. The chemicals for cattails and other emergents are sprayed so as to thoroughly wet all exposed foliage. Paraquat and amitrole are most effective when cattails are coming into head. Consult the manufacturer's directions.

The vegetation also varies widely; species include completely submerged ones such as *Elodea* (*Elodea canadensis* - Canada waterweed) and algae; free floating ones such as water lilies and emergent plants. Many emergents will grow equally as well on the moist shoreline as when their lower stems and roots are in water. Where these emergent species have taken possession of the shoreline, control measures must embrace that area as well as the water.

Chara (Chara stonewort, muskgrass) are a gray green to green plant-like algae, attached to the sediment, or free floating which in dense communities has a very strong musk odour. It is brittle to the touch and will dry to a white powder upon removal from the water. This plant is difficult to control with moderate doses of algaecides and dense communities should be removed mechanically. Tapegrass (wild celery*) (Vallisneria americana*); found in many recreational lakes, is resistant to all the currently recommended herbicides. It has long rubbery leaves and numerous short roots. Control is possible only by mechanical methods such as pulling.

Diquat (REWARD) provides good control of a wide variety of submergent species including water-milfoil, pondweeds, *Elodea canadensis (*Canada waterweed) and Coontail. This herbicide is not effective against *Chara spp.* (Muskgrass) and *Nitella sp.* Diquat should be applied on cloudy days in late afternoon and care should be taken not to stir up the bottom since turbidity reduces the effectiveness of treatment. Since diquat takes effect rapidly, decomposition of a large plant mass may deplete oxygen levels which can cause fish to suffocate. Thus, in ponds where fish are present and growth is well established, no more than 1/4 to 1/2 of the pond should be treated at one time. Wait two weeks before treating again. The best time to apply these chemicals is late spring while the plants are growing rapidly. Since this is a contact chemical, control is achieved for one season, and repeat treatments must be made annually.

AQUATIC PLANTS

TABLE 12–8. Habitats and Herbicide Susceptibility of Common Aquatic Plants

	spring-fed pond	dugout	soft water lake*	nard water lake **	wet ditch ***	dry ditch****	Mechanical Control	Copper compound (1)	Diquat (2)	Paraquat (3)	Amitrole (4)
Algae											
Spirogyra spp.	VC	VC	C-I		VC	I		S	R		
Ulothrix spp.	C	VC			VC			S	R		
Mougeotia spp.	C	VC			VC			S	R		
Cladophora spp.	VC	VC	C	VC	VC	VC		S	R		
Chara spp. (Muskgrass)	VC	I	C-I	VC-I	VC	R		S	R		
Nitella spp. (Stonewort)	I	R	VC	R	R	R		S	R		
Submergent Macrophytes											
Sago pondweed (P. pectinatus)	I	C-I		VC				R	S		
Curly-leaf pondweed (P.crispus)	C	VC		VC				R	S		
Bassweed (P.amplifolius)	R	C		C				R	I		
Richardson pondweed (P. richardsonii)				VC-C				R	S-I		
Flat-stemmed pondweed (P. zosteriformis)				C				R	S		
other narrow-leaf pondweed (Potamogeton spp.)	I	C	C	VC-C				R	S		
Eurasian water milfoil (Myriophyllum spicatum)			VC					R	VS		
Native milfoil (M. exalbescens and others)	C		C	VC				R	VS		
Bladderwort (Utricularia vulgaris)		C		C				R	S-I		
Coontail (Ceratophyllum demersum)		C		VC				R	I		
Water stargrass (Heterantheria dubia)				C				R	S-I		
Tape grass (Vallisneria americana)	R	I	C	VC	R	R	M**	R	R	R	R
Water naiad (Najas flexilis)		I		VC				R	S		
Canada water weed (Elodea canadensis)		C		VC				R	I		
Emergents											
Cattails (T. latifolia, T angustifolia)	VC	VC		VC	VC	I-C	M	R	R	I	S-I
Bulrush (Scirpus spp.)			C	VC	C	C	M	R			S-I

AQUATIC PLANTS

TABLE 12–8. Habitats and Herbicide Susceptibility of Common Aquatic Plants

	spring-fed pond	dugout	soft water lake*	hard water lake **	wet ditch ***	dry ditch****	Mechanical Control	Copper compound (1)	Diquat (2)	Paraquat (3)	Amitrole (4)
Sedge (Carex spp+A42.)			C	C	C	VC	M	R			S-I
Bur reed (Sparganium spp.)	C		C	C	C	VC	M	R			I
Water plantain (Alisma spp.)			I	C	C	VC		R			S
Pipewort (Eriocaulon spp.)	R	R	C	R	R	R	M*	R		S	
Arrowhead (Sagittaria spp.)		C		VC	I-C			R		S	
Pickerelweed (Pontederia spp.)			VC		I	R		R		S-I	
Water smartweed (Polygonium amphibium)	I	I						R		S-I	
Water shield (Brasenia spp.)			C					R		S-I	
White water lily (Nymphaea spp.)			C	C			M*	R		I	
Yellow water lily (Nuphar spp.)		C-I	C	C			M*	R		I	
Duckweed (Lemna spp.)	R	C	I-R	VC				R	S	S	
Duckmeal (Wolffia spp.)	R	C-I	I-R	VC				R	S	S	

VC – very common, C – common, I – infrequent, R – rare
M – manual or mechanical methods equally as effective as herbicides
M* – manual or mechanical methods are generally more effective than herbicides
M** – manual or mechanical methods are the only control measure currently available
S – susceptible, I – Intemediate, R – resistant
Bur reed is also very common as a submerged plant in ecotypes C and D

* A typical Muskoka lake is an example of a soft water lake
** A typical Kawartha lake is an example of a hard water lake
*** A wet ditch contains water at time of treatment
**** A dry ditch contains no water at time of treatment

1 – Copper compound (Cutrine Plus)
2 – Diquat (Reglone A)
3 – Paraquat (Gramoxone)
4 – Amitrole (Amitrole 240)

13. Pesticide Tables

TABLE 13–1. Pesticides Used on Fruit Crops in Ontario

BRAND or TRADE NAME*	Common Name or Active Ingredient	Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
2,4-D	*see* Estemine 2,4-D, 2,4-D Amine 600							
2,4-D Amine 600	2,4-D	h	Group 4	EC	564g/L	2	C	INT
abamectin	*see* AGRI-MEK 1.9% EC							
ADMIRE	imidacloprid	i	chloronicotine	Fl	240 g/L	5		BBB
AFOLAN F	linuron	h	Group 7	Su	480 g/L	3	A	AET
AGRI-MEK 1.9% EC	abamectin	ai	avermectin	EC	19 g/L	3		ENG
ALIETTE WDG	fosetyl al	f	phosphonate	WG	80%	5		AET
amitraz	*see* MITAC W							
amitrole	*see* AMITROL 240							
AMITROL 240	amitrole	h	Group 11	SC	231 g/L	2	E	NUA
APM 50W Instapak	azinphos-methyl	i	organophosphate	WP	50%	5		NRA
APOLLO SC	clofentezine	ai	tetrazine	SC	500 g/L	2		MKC
AQUASHADE	water soluble dyes			Li	26%	2	A	APB
azinphos-methyl	*see* APM 50W Instapak, GUTHION, SOLUPAK, SNIPER, SNIPER 240E							
bacillus thuringiensis var Kurstaki	*see* BIOPROTEC CAF							
bacillus thuringiensis	*see* DIPEL 2XDF, FORAY 48BA, BIOPROTEC CAF							
BASAGRAN	bentazon	h	Group 6	Sn	480 g/L	3	B	BAZ
BENLATE Toss-N-Go	benomyl	f	benzimidazole	WP	50%	3		DUQ
benomyl	*see* BENLATE							

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Weed Committee or the Ontario Crop Protection Committee. Neither does this signify that these products are approved to the exclusion of comparable products. All TRADE NAMES are captialized.

[1] See Table 13–2, *Ontario Classification Schedules*, page 275.

[2] See Table 13–4, *Pest Control Product Companies*, page 280.

† **a** — acaracide, miticide; **b** — bactericide; **f** — fungicide; **h** — herbicide; **i** — insecticide; **n** — nematicide; **r** — rodenticide; **md** — mating disrupter

‡ symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **EW** — water based concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder

Winter Storage: **A** — Do not allow to freeze; **B** — Preferably should not freeze. If frozen, return to original state by allowing product to warm up to 10°C–20°C and agitate thoroughly before use. **C** — Not usually damaged by freezing. Store in a cool, dry place; **D** — Do not allow to freeze. Store above 10°C; **E** — Do not allow to freeze. Store above 4°C.

TABLE 13–1. Pesticides Used on Fruit Crops in Ontario (Continued)

BRAND or TRADE NAME*	Common Name or Active Ingredient	Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
bentazon	*see* BASAGRAN							
BIOPROTEC CAF	bacillus thuringiensis var Kurstaki	i	Bt microbial	Li	12.7 BIU/L	3		AEF
BONANZA 400	trifluralin	h	Group 3	EC	400 g/L	3	B	UAG
BOTRAN 75W	dicloran	f	chlorophenyl	WP	75%	3		GOW
BRAVO 500	chlorothalonil	f	chloronitrile	Fl	500 g/L	3		SYN
captan	*see* CAPTAN 80 WDG, MAESTRO 80 DF							
CAPTAN 80 WDG	captan	f	phthalimide	WP	50%	3		MKC, AVA
carbaryl	*see* SEVIN XLR PLUS							
carbofuran	*see* FURADAN 480F							
CARZOL SP	formetanate hydrochloride	a, i	carbamate	SP	92%	5		GOW
CASORON 4G	dichlobenil	h	Group 20	Gr	4%	3	C	UNR
chlorophacinone	*see* ROZOL							
chlorothalonil	*see* BRAVO 500							
chlorpyrifos	*see* LORSBAN 4E							
clofentezine	*see* APOLLO SC							
clopyralid	*see* LONTREL 360							
CONFIRM 240F	tebufenozide	i	ecdysone disrupter	Fl	240 g/L	2		DWE
COPPER 53W	tri-basic copper sulphate	b	inorganic	WP	53%	2		UAG
copper ethanolamine	*see* CUTRINE PLUS							
CUTRINE PLUS	copper ethanolamine	h		Sn	9%	2	A	APB
CUTRINE PLUS (GRANULAR)	copper ethanolamine	h		Gr	3.7%	2	B	APB
CYGON 480	dimethoate	i	organophosphate	EC	480 g/L	2		BAT
CYGON 480-Ag	dimethoate	i	organophosphate	EC	480 g/L	2		CUA
cyhalothrin lambda	*see* MATADOR 120 EC							

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[1] See Table 13–2, *Ontario Classification Schedules*, page 275.

[2] See Table 13–4, *Pest Control Product Companies*, page 280.

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C — Not usually damaged by freezing. Store in a cool, dry place; **D** — Do not allow to freeze. Store above 10°C; **E** — Do not allow to freeze. Store above 4°C.

TABLE 13–1. Pesticides Used on Fruit Crops in Ontario (Continued)

BRAND or TRADE NAME*	Common Name or Active Ingredient	Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
CYMBUSH 250EC	cypermethrin	i	synthetic pyrethroid	EC	250 g/L	2		SYN
cypermethrin	*see* CYMBUSH 250 EC, RIPCORD 400 EC							
cyprodinil	*see* VANGARD 75 WG							
DECIS 5 EC	deltamethrin	i	synthetic pyrethroid	EC	50 g/L	2		AET
deltamethrin	*see* DECIS 5 EC							
DEVRINOL 50W	napropamide	h	Group 15	WP	50%	3	C	UAG
DEVRINOL DF	napropamide	h	Group 15	DF	50%	3	C	UAG
diazinon	*see* DIAZINON 50W, DIAZINON 500E, DZN 600 EW							
DIAZINON 500 E	diazinon	i	organophosphate	E	50%	2		UAG
DIAZINON 50W	diazinon	i	organophosphate	W	50%	2		UAG
dichlobenil	*see* CASORON 4G							
dicloran	*see* BOTRAN 75W							
dicofol	*see* KELTHANE 50W							
DIKAR	no common name	a,f	dithiocarbamate	WP	72%	3		DWE
dimethoate	*see* CYGON 480, CYGON 480 AG							
DIPEL 2X DF	bacillus thuringiensis	i	Bt microbial	WP	16,000/mg	3		VAN
diphacinone	*see* RAMIK BROWN							
diquat(aquatic)	*see* REWARD							
DITHANE DG	mancozeb	f	dithiocarbamate	DG	75%	3		DWE
DITHANE M45	mancozeb	f	dithiocarbamate	WP	80%	3		DWE
diuron	*see* KARMEX							
dodine	*see* EQUAL 65 WP							
DUAL MAGNUM	s-metolachlor	h	Group 15	EC	915 g/L	2	B	SYN
DZN 600EW	diazinon	i	organophosphate	EW	600 g/L	3		ENG
ELEVATE 50 WDG	fenhexamid	f	hydroxyanaline	WDG	50%	3		AVA

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‡ symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **EW** — water based concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder

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TABLE 13–1. Pesticides Used on Fruit Crops in Ontario (Continued)

BRAND or TRADE NAME*	Common Name or Active Ingredient	Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
endosulfan	*see* ENDOSULFAN 50 W, THIODAN 4 EC, THIODAN 50 WP, THIONEX 50 WP							
ENDOSULFAN 50W	endosulfan	i	chlorinated cyclodiene	WP	50%	2		UAG
EQUAL 65 WP	dodine	f	guanidine	WP	65%	3		NRA
ESTEMINE 2,4-D	2,4-D	h	Group 4	Sn	470 g/L	3	A	UAG
EXPEDITE GRASS and WEED	glyfosate	h	Group 9	Sn	147 g/L	3	A	MOX
fenhexamid	*see* ELEVATE 50 WDG							
ferbam	*see* FERBAM 76 WDG							
FERBAM 76 WDG	ferbam	f	dithiocarbamate	WG	76%	3		UAG
fluazifop-p-butyl	*see* VENTURE L							
flusilazole	*see* NUSTAR							
FOLPAN 50 WP	folpet	f	phthalimide	WP	50%	2,3		UAG, MKC
folpet	*see* FOLPAN 50 WP							
FORAY 48BA	bacillus thuringiensis	i	Bt microbial	Li	10,600/mg	3		VAN
formetanate hydrochloride	*see* CARZOL SP							
fosetyl al	*see* ALIETTE WDG							
FUNGINEX 190 EC	triforine	f	piperazine	EC	190 g/L	6		BAZ
FURADAN 480F	carbofuran	i	carbamate	Fl	480 g/L	5		BBB
GAVEL 75 DF	zoxamide/mancozeb	f	benzimidazole, dithiocarbamate	DF	8.3% + 66.7%	3		DWE
glufosinate ammonium	*see* IGNITE							
GLYFOS	glyphosate	h	Group 9	Sn	360 g/L	6	B	CAU
glyphosate	*see* LAREDO, RENEGADE, ROUNDUP TRANSORB, GLYFOS, EXPEDITE GRASS & WEED, WRANGLER							
glyphosate TMS	*see* TOUCHDOWN 480							
GRAMOXONE	paraquat	h	Group 22	Sn	200 g/L	2	A	SYN
GUTHION SOLUPAK	azinphos-methyl	i	organophosphate	WP	50%	5		BBB

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TABLE 13–1. Pesticides Used on Fruit Crops in Ontario (Continued)

BRAND or TRADE NAME* Common Name or Active Ingredient		Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
IGNITE	glufosinate ammonium	h	Group 10	Sn	150 g/L	3	A	AET
imidacloprid	*see* ADMIRE							
IMIDAN 50 WP	phosmet	i	organophosphate	WP	50%	3		GOW
iprodione	*see* ROVRAL							
ISOMATE - GBM	pheromone, grape berry moth	md	pheromone	DIS		3		PBC, BAT
KARMEX	diuron	h	Group 7	DF	80%	2	C	GRN
KELTHANE 50W	dicofol	a	diphenylethane	WP	50%	2		DWE
KERB	propyzamide	h	Group 15	WP	50%	3	C	DWE
kresoxim-methyl	*see* SOVRAN							
KUMULUS DF	sulphur	f	inorganic	DF	80%	6		BAZ
LANNATE	methomyl	i	carbamate	SC	215 g/L	2		DUQ
LAREDO	glyphosate	h	Group 9	Sn	356 g/L	3	B	MOX
LEXONE DF	metribuzin	h	Group 5	DF	75%	2	C	DUQ
LIME SULPHUR	sulphide sulphur	f	inorganic		22%			UAG
linuron	*see* AFOLAN F, LINURON 480, LOROX DF, LOROX L							
LINURON 480	linuron	h	Group 7	Su	480 g/L	3	A	UAG
LONTREL 360	clopyralid	h	Group 4	Sn	360 g/L	2	A	DWE
LOROX DF	linuron	h	Group 7	DF	50%	3	C	GRN
LOROX L	linuron	h	Group 7	Su	480 g/L	3	A	GRN
LORSBAN 50W	chlorpyrifos	i	organophosphate	WP	50%	2		DWE
MAESTRO 80 DF	captan	f	phthalimide	DF	75%	2		AVA
malathion	*see* MALATHION 25 W							
MALATHION 25W	malathion	i	organophosphate	WP	25%	3		WBR, UAG
mancozeb	*see* MANZATE 200 WP, MANZATE 200 DF, DITHANE DG, DITHANE M45, GAVEL 75DF, PENNCOZEB 75 DF							
MANZATE 200 DF	mancozeb	f	dithiocarbamate	DF	75%	3		GRN

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BRAND or TRADE NAME*	Common Name or Active Ingredient	Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
MANZATE 200 WP	mancozeb	f	dithiocarbamate	WP	80%	3		GRN
MATADOR 120 EC	cyhalothrin lambda	i	synthetic pyrethroid	EC	120 g/L	2		SYN
MCPB/MCPA	TROPOTOX PLUS		Group 4	Sn	400 g/	3	A	NUA
MERTECT SC	thiabendazole	f	benzimidazole	SC	500 g/L	3		SYN
metalaxyl + copper hydroxide	*see* RIDOMIL/ COPPER							
metalaxyl + mancozeb	*see* RIDOMIL GOLD MZ 68 WP							
metalaxyl-M	*see* RIDOMIL GOLD 480 EC							
metam sodium	*see* VAPAM							
methomyl	*see* LANNATE							
methyl bromide/ chloropicrin	*see* TERR-O-GAS 67							
metiram	*see* POLYRAM DF							
metolachlor	*see* DUAL MAGNUM							
metribuzin	*see* LEXONE DF, SENCOR 75 DF, SENCOR SOLUPAK							
MICROSCOPIC SULPHUR	sulphur	f	inorganic		92%			UAG, BAT
mineral oil	*see* SUPERIOR OIL							
MITAC W	amitraz	i	triazapentadiene	WP	50%	2		AET
myclobutanil	*see* NOVA 40 W							
napropamide	*see* DEVRINOL 50W, DEVRINOL DF							
NOVA 40W	myclobutanil	f	triazole (DMI)	WP	40%	2		DWE
NUSTAR	flusilazole	f	DMI	DF	20%	3		DUQ
oxamyl	*see* VYDATE							
paraquat	*see* GRAMOXONE							
parathion	*see* PARATHION 15W							
PARATHION 15W	parathion	i	organophosphate	WP	15%	5		UAG
PENNCOZEB 75DF	mancozeb	f	dithiocarbamate	DF	75%	3		EFA

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TABLE 13–1. Pesticides Used on Fruit Crops in Ontario (Continued)

BRAND or TRADE NAME[*] Common Name or Active Ingredient		Use[†]	Chemical Family or Activity Group	Formulation[‡]	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
permethrin	*see* POUNCE							
pheromone	*see* ISOMATE - GBM GRAPE BERRY MOTH PHEROMONE							
phosalone	*see* ZOLONE							
phosmet	*see* IMIDAN							
pirimicarb	*see* PIRIMOR 50 DF							
PIRIMOR 50DF	pirimicarb	i	carbamate	DF	50%	2		SYN
POAST ULTRA	sethoxydim	h	Group 1	EC	450 g/L	3	B	BAZ
POLYRAM DF	metiram	f	dithiocarbamate	DF	80%	3		BAZ
POUNCE	permethrin	i	pyrethroid	EC	384 g/L	3		UAG,BBB
PRINCEP NINE-T	simazine	h	Group 5	WG	90%	2	C	SYN
propiconazole	*see* TOPAS 250 E							
propyzamide	*see* KERB							
PYRAMITE	pyridaben	a, i	pyridazinone	WP	75%	2		BAZ
Pyridaben	*see* PYRAMITE							
RAMIK BROWN	diphacinone	r		pellets	0.005%	6		UAG,HOK
REWARD	Diquat (aquatic)	h	Group 22	Li	240 g/L	2	A	SYN
RENEGADE	glyphosate	h	Group 9	Sn	356 g/L	3	B	MOX
RIDOMIL GOLD 480 EC	metalaxyl-M	f	acylamine	EC	480 g/L	2		SYN
RIDOMIL GOLD MZ 68 WP	metalaxyl+ mancozeb	f	acylamine + dithiocarbamate	WP	68%	2		SYN
RIDOMIL/COPPER	metalaxyl + copper hydroxide	f	acylamine + inorganic	WP	70%	2		SYN
RIPCORD 400 EC	cypermethrin	i	pyrethroid	EC	400 g/L	2		BAZ
RIVAL	trifluralin	h	Group 3	EC	500 g/L	3	A	AET
RONILAN EG	vinclozolin	f	dicarboximide	DF	50%	2		BAZ
ROUNDUP FASTFORWARD PRESEED	glyphosate/glufosinate ammonium	h	Group 9, 10	Sn	(30:1) 310 g/L	3	B	MOX

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BRAND or TRADE NAME*	Common Name or Active Ingredient	Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
ROUNDUP TRANSORB	glyphosate	h	Group 9	Sn	360 g/L	3	B	MOX
ROVRAL	iprodione	f	dicarboximide	WP	50%	3		AET
ROZOL	chlorophacinone	r		pellets	0.005	3,6		UAG,LPH
SENATOR 70 WP	thiophanate-methyl	f	benzimidazole	WP	70%	2		ENG
SENCOR 75 DF	metribuzin	h	Group 5	WG	75%	2	C	BBB
SENCOR SOLUPAK	metribuzin	h	Group 5	WG	75%	2	C	BBB
sethoxydim	*see* POAST ULTRA							
SEVIN XLR PLUS	carbaryl	i	carbamate	Su	480 g/L	3		AET
SIMADEX	simazine	h	Group 5	Su	500 g/L	2	A	AET
simazine	*see* PRINCEP NINE-T, SIMADEX, SIMAZINE 480, SIMAZINE 80W							
SIMAZINE 480	simazine	h	Group 5	Su	480 g/L	2	A	UAG
SIMAZINE 80W	simazine	h	Group 5	WP	80%	2	C	UAG
SINBAR	terbacil	h	Group 5	WP	80%	2	C	DUQ
SNIPER	azinphos- methyl	i	organophosphate	WP	50%	5		UAG
SNIPER 240E	azinphos-methyl	l	organophosphate	E	240 g/L	5		UAG
SOVRAN	kresoxim-methyl	f	strobilurin	WG	50%	3	A	BAZ
spinosad	*see* SUCCESS 480 SC							
STREPTOMYCIN 17	streptomycin sulphate	b		WP	17%	3		UAG
streptomycin sulphate	*see* STREPTOMYCIN 17							
SUCCESS 480 SC	spinosad	i	naturalyte	SC	480 g/L	3		DWE
sulphur	*see* KUMULUS, MICROSCOPIC SULPHUR							
SUPERIOR 70 OIL	mineral oil	ai		Li	98.5%	6		BAT, UAG
tebufenozide	*see* CONFIRM 240 F							
TELONE C-17	dichloropropene + chloropicrin	bfhin		Li	78% + 14%	2		DWE
TELONE II-B	dichloropropene	n		Li	94%	2		DWE

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Winter Storage: **A** — Do not allow to freeze; **B** — Preferably should not freeze. If frozen, return to original state by allowing product to warm up to 10°C–20°C and agitate thoroughly before use. **C** — Not usually damaged by freezing. Store in a cool, dry place; **D** — Do not allow to freeze. Store above 10°C; **E** — Do not allow to freeze. Store above 4°C.

TABLE 13–1. Pesticides Used on Fruit Crops in Ontario (Continued)

BRAND or TRADE NAME* Common Name or Active Ingredient		Use†	Chemical Family or Activity Group	Formulation‡	Guaranteed % (active unless stated)	Ont. Sch.[1]	Winter Storage	Man/Agent's Code[2]
terbacil	*see* SINBAR							
TERR-O-GAS 67	methyl bromide/ chloropicrin	h		Li	67% + 31%	1		GRC
thiabendazole	*see* Mertect SC							
THIODAN 4EC	endosulfan	i	chlorinated cyclodiene	EC	50%	2		AET
THIONEX 50 WP	endosulfan	i	chlorinated cyclodiene	WP	50%	2		UAG
THIODAN 50 WP	endosulfan	i	chlorinated cyclodiene	WP	50%	2		AET
thiophanate methyl	*see* SENATOR 70 WP							
TOPAS 250E	propiconazole	f	triazole (DMI)	EC	250 g/L	2		ENG
TOUCHDOWN 480	glyphosate TMS	h	Group 9	Sn	330 g/L	6	B	SYN
TREFLAN EC	trifluralin	h	Group 3	EC	480 g/L	3	A	DWE
tri-basic copper sulphate	*see* COPPER 53 W							
trifluralin	*see* BONANZA 400, RIVAL, TREFLAN EC							
triforine	*see* FUNGINEX 190 EC							
TROPOTOX PLUS	MCPB/MCPA	h	Group 4	Sn	400 g/L	3	A	NUA
VANGARD 75 WG	cyprodinil	f	anilinopyrimidine	WG	75%	3		ENG
VAPAM	metam sodium	bfhin	Group 27	Sn	380 g/L	3	C	UAG
VENTURE L	fluazifop-p-butyl	h	Group 1	EC	125 g/L	5	C	SYN
Vinclozolin	*see* RONILAN EG							
VYDATE	oxamyl	in	carbamate	Li	240 g/L	5		DUQ
water soluble dyes	*see* AQUASHADE							
WRANGLER	glyphosate	h	Group 9	Sn	356 g/L	3	B	MOX
zineb	*see* ZINEB 80W							
ZINEB 80W	zineb	f	dithiocarbamate	WP	80%	3		UAG
ZOLONE FLO	phosalone	i	organophosphate	Fl	500 g/L	2		AET
zoxamide/mancozeb	*see* GAVEL 75 DF							

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* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Weed Committee or the Ontario Crop Protection Committee. Neither does this signify that these products are approved to the exclusion of comparable products. All TRADE NAMES are captialized.

[1] See Table 13–2, *Ontario Classification Schedules*, page 275.

[2] See Table 13–4, *Pest Control Product Companies*, page 280.

† **a** — acaracide, miticide; **b** — bactericide; **f** — fungicide; **h** — herbicide; **i** — insecticide; **n** — nematicide; **r** — rodenticide; **md** — mating disrupter

‡ symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **EW** — water based concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder

Winter Storage: **A** — Do not allow to freeze; **B** — Preferably should not freeze. If frozen, return to original state by allowing product to warm up to 10°C–20°C and agitate thoroughly before use. **C** — Not usually damaged by freezing. Store in a cool, dry place; **D** — Do not allow to freeze. Store above 10°C; **E** — Do not allow to freeze. Store above 4°C.

TABLE 13–2. Ontario Pesticide Classification Schedules

The Ontario Ministry of the Environment reviews each pesticide product offered for sale in Ontario and classifies it into one of 6 groupings called Schedules.

Schedule	Who Can Use It	Pesticide Characteristics*
1	licensed applicator certified grower only with approved permit	Very Toxic and/or Very Persistent and/or Highly Mobile
5	licensed applicator certified grower assistant agriculturist under supervision	Very Toxic and/or Very Persistent and/or Highly Mobile Less toxic or less persistent alternative not available
2	licensed applicator certified grower trainee or technician under supervision (some restrictions apply) assistant agriculturist under supervision	Toxic, and/or Persistent, and/or Moderately Mobile
3	Any person	Moderately Toxic, and/or Moderately Persistent, and/or Slightly Mobile
4	Any person	Low Toxicity Non-persistent Non-mobile Containers < 1kg < 1L
6	Any person	Low Toxicity Non-persistent Non-mobile Containers > 1 kg > I L

* Biological persistence and mobility in the environment, as expected under normal use conditions for Ontario.

Certification and Training Requirements: You must be a Certified Grower or a Licensed Applicator (Exterminator) to buy and use Schedule 1, 2 and 5 pesticides.

TABLE 13–3. Number of Days from Last Spray to Harvest

Read the label and follow all safety precautions.
Health Canada has established amounts of pesticides that may remain on fruits at time of harvest. To avoid exceeding these tolerances, use recommended amounts and do not spray nearer to harvest than number of days shown below, or not later than stage indicated. For tank mixes of 2 or more materials, use the longest period given for any of the materials. **Be aware that many processors may require longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Do not apply a pesticide more often than recommended on label.**

	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
2,4-D	80	80	80	80	80		N	N	80		
ADMIRE	7										
AGRI-MEK 1.9EC	28	28									
ALIETTE WDG	30						60	30			
AMITROL - 240	30										
APM 50W Instapak	7	7	15	21	15	28	14				14
APOLLO SC	A	21		A, 21			15	15			
BENLATE T-N-G	1	1	1	2	2	7	2	2	2		
BIOPROTEC	0										
BOTRAN 75W				10							
BRAVO 500			40	60				30			54
CAPTAN 80 WDG	7	7	5*	2	2	7	2	2	2		2
CARZOL SP	1	1		21							
CONFIRM 240 F	14										
COPPER 53 W	30					1		1			
CYGON 480	14							7			15
CYMBUSH 250 EC	7	7		7		7		7			
DECIS 5EC	1	7		1				14			14
DEVRINOL DF	N	N	V	N	V	N	N	N	V		70
DIAZINON 50 W	14	14	10		10	16	PB			PB	
DIAZINON 500 E							PB			PB	
DIKAR	45	45				30					
DIPEL 2X DF	1	1					1		1		
DITHANE DG	45										

A — within 14 days of petal fall
B — not used alone
C — Do not use later than recommended here
PB — prebloom

PH — postharvest
N — No preharvest interval on label
V — vegetative or non-bearing year only

* 2 days on sweet cherry
** 1 day on table grapes

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	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
DITHANE M-45						30					
DZN 600 EW			10		10	16	PB			PB	
ELEVATE 50 WDG						7		1			
ENDOSULFAN 50W	15	15	15	15	15	30		7			
EQUAL 65 WP		7	7					7			
FERBAM 76 WDG	7		4	21		7	PB		21	14	40
FOLPAN 50 WP						1		1			
FORAY 48 BA	1	1					1				
FUNGINEX 190 EC			C	C	C						60
FURADAN 480 F								PB			
GAVEL 75DF						66					
GUTHION 240 EC						28					
GUTHION SOLUPAK	14	14	15	21	15	28	14		21		14
IGNITE	40	40		40	40	40					
IMIDAN 50 WP	1	1	7	1	1	7					15
KELTHANE 50 W	7	7	7	14	7	7		7	14		
KUMULUS DF	1		1			21**					
LANNATE	8										
LAREDO	30	30	30	30	30	14		30	30		30
LONTREL 360	30							200			45
LORSBAN 50 W				21							
MAESTRO 80 DF	7	7	5*	2	2	7	2	2	2		2
MALATHION 25 W							1			3	1
MANZATE 200 DF	45										

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	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
MANZATE 200 WP		45				30					
MATADOR	7	7	7	7	7			7			
MITAC W		14									
NOVA 40 W	14		1	1		14					
NUSTAR	77										
PARATHION 15 W		14		14	14				14		
PENNCOZEB 75 DF	45										
PIRIMOR 50 DF	35			60							
POAST ULTRA	25	25	25	25	25		37	25	25		15
POLYRAM DF	45					45					
POUNCE	7	7		7		21					
PYRAMITE	25	25		14		25	PH	10			
RENEGADE	30	30	30	30	30	14		30	30		30
RIDOMIL GOLD 480 EC	V						V, PH	V, PH			
RIDOMIL GOLD MZ						PB					
RIDOMIL/COPPER						66					
RIPCORD 400 EC	7	7						7			
RONILAN EG								3			
ROUNDUP	30	30	30	30	30	14		30	30		30
ROVRAL			1	1	1	7	1	1	1		
SENATOR 70 WP							1				
SEVIN XLR PLUS	11	11	2	1	2	5					2
SNIPER	14	14	15	21	15	28	14		21		14
SOVRAN	30										

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	Apple	Pear	Cherry	Peach & Nectarine	Plum	Grape	Blackberry & Raspberry	Strawberry	Apricot	Currant & Gooseberry	Blueberry
STREPTOMYCIN 17	50	30									
SUCCESS 480 SC	7										
SULPHUR 92 WP	1	1	1	1	1	21**				1	
THIODAN 50 WP	15	15	15	15	15	30		7	15		
THIODAN 4 EC	15	15	15	15	15	30		7			
THIONEX 50 WP				15							
TOPAS 250 E			3	3	3				3		60
TOUCHDOWN 480	30	30	30	30	30	14		30	30		30
VANGARD 75 WG	72			2	2	7			2		
VENTURE L	N	N	N	N	N		30	30	30		30
VYDATE	V						PH				
WRANGLER	30	30	30	30	30	14		30	30		30
ZINEB 80 W	45	45									
ZOLONE FLO	30		14								

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TABLE 13–4. Pest Control Product Companies

Code*	Registrant or agent	Web Site	Contact number
AEF	AEF Global Inc.	www.enviroaccess.ca/pages/aef_en.html	1-819-348-9461
AET	Aventis Cropscience Canada Co.	www.ca.cropscience.aventis.com	1-888-283-6847
APB	Applied Biochemists Inc	ww.appliedbiochemists.com	1-800-558-5106
ARV	Agrevo Canada (Aventis)		1-888-283-6847
AVA	Arvesta	www.arvesta.com	1-519-766-1117
BAT	Bartlett, N.M. Inc		1-905-563-8261
BAZ	Basf Canada Inc	www.agsolutions.ca/	1-877-371-2273
BBB	Bayer Inc	www.bayer.ca/	1-800-268-1331
CAU	Cheminova	www.cheminova.com/	1-888-316-6260
DUQ	Dupont Canada Inc.	www.dupont.ca/ag	1-800-667-3925
DWE	Dow Agro Science Canada	www.Dowagro.com	1-800-667-3852
EFA	Cerexagri Inc. (Ato fina Canada)		1-905-827-9841
ENG	Engage Agro Corp	www.engageagro.com	1-800-900-5487
GOW	Gowan Company	www.gowanco.com	1-520-783-8844
GRC	Great Lakes Chemical Corp	www.greatlakescorp.com	1-800-428-7947
GRN	Griffin Corp	www.griffinllc.com	1-912-242-8635
HOK	Hacco Inc.		1-608-221-6200
INT	Interprovincial Coop Ltd		1-204-233-3461
LPH	Lipha Tech		1-414-351-1476
MKC	Makhteshim		1-416-233-1496
MOX	Monsanto	www.monsanto.com	1-800-667-4944
NLC	Nalco Canada Inc.	www.nalco.com	1-905-623-8791
NRA	Norac Concepts	www.noracconcepts.com	1-613-841-2907
NUA	Nufarm	www.amitrol.com	1-800-868-5444
NUG	Nu-gro Corp	www.nugro.com	1-800-461-7356
PBC	Pacific Biocontrol		1-360-571-2247
RHQ	Rhone-Poulenc Canada (Aventis)		1-888-283-6847
SYN	Syngenta Crop Protection		1-800-797-5040
UAG	United Agri Products	www.uap.ca	1-800-265-4624
UNR	Crompton Company		1-800-265-2157
VAN	Valent Biosciences		1-905-659-0886
VAR	VanWaters & Rogers Ltd.	www.vwr-ltd.com	1-800-265-7671
WBR	Wilbur-Ellis Co. Canada	www.wilburellis.com	1-559-442-1220

* The 3-letter manufacturer's codes represent the codes listed in Table 13–1, *Pesticides Used on Fruit Crops in Ontario,* on page 266 and Table 12–3, *Adjuvants Used in Ontario,* on page 204.

14. Appendices

APPENDIX A. Ontario Ministry of Agriculture, Food and Rural Affairs Advisory Staff List

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APPENDIX A. Ontario Ministry of Agriculture, Food and Rural Affairs Advisory Staff List

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General Phone (519) 824-4120
50 Stone Road East Guelph, ON N1G 2W1

Applied Research Coordinator – Field Crops, Crop Science Building	Ian McDonald	(519) 824-4120 Ext. 6707 Fax (519) 763-8933	ian.mcdonald@omafra.gov.on.ca
Corn Industry Program Lead Crop Science Building	Greg Stewart	(519) 824-4120 Ext. 4865 Fax (519) 763-8933	greg.stewart@omafra.gov.on.ca
Nursery Crops Specialist Edmund Bovey Building	Jennifer Llewellyn	(519) 824-4120 Ext. 2671 Fax (519) 767-0755	jennifer.llewellyn@omafra.gov.on.ca
Nutrition – Horticulture Program Lead Land Resource Science Richards Building	Christoph Kessel	(519) 824-4120 Ext. 2480 Fax (519) 824-5730	christoph.kessel@omafra.gov.on.ca
Pathologist – Horticulture Crops Program Lead, Edmund Bovey Building	Michael Celetti	(519) 824-4120 Ext. 8910 Fax (519) 767-0755	michael.celetti@omafra.gov.on.ca
Turfgrass Specialist Guelph Turfgrass Institute 328 Victoria Rd S R. R. # 2 Guelph, ON N1H 6H8	Pam Charbonneau	(519) 824-4120 Ext. 2597 Fax (519) 766-1704	pamela.charbonneau@omafra.gov.on.ca
Weed Management Field Crops Program Lead, Crop Science Building	Vacant		

Agricultural Information Contact Centre
General Phone (877) 424-1300 or (519) 826-4047 Fax (519) 826-7610

Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses.

1 Stone Road, West Guelph ON N1G 4Y2 e-mail ag.info@omafra.gov.on.ca

Guelph — Government Information Centre
Staff Directories — Phone 1-888-466-2372 or (519) 826-3100
1 Stone Road West Guelph ON N1G 4Y2

APPENDIX B. Tissue Testing and Accredited Soil Testing Laboratories in Ontario

The following labs are accredited to perform soil tests for pH, buffer pH, P, K, Mg and Nitrate-N on Ontario soils.

Company	Address		Contact
A & L Canada Laboratories East, Inc. 2136 Jetstream Road London, Ontario N5V 3P5	Tel (519)457-2575 Fax (519) 457-2664	Web www.al-labs-can.com email aginfo@al-labs-can.com	Greg Patterson Ian McLachlin
Accutest Laboratories 146 Colonnade Road, Unit #8 Nepean, Ontario K2E 7Y1	Tel (613) 727-5692 Fax (613) 727-5222	Web www.accutestlabs.com email phaulena@accutestlabs.com	Lorna Wilson Peter Haulena
Agri-Food Laboratories 503 Imperial Road, Unit #1 Guelph, Ontario N1H 6T9	Tel (519) 837-1600 1-800-265-7175 Fax (519) 837-1242	Web www.agtest.com email lab@agtest.com	Dale Cowan Nora Wilson
Soil and Nutrient Laboratory University of Guelph P.O. Box 3650, 95 Stone Road West Guelph, Ontario N1H 2W1	Tel (519) 767-6226 Fax (519) 767-6240	email info@lsd.uoguelph.ca	Virginia Kerslake
Stratford Agri Analysis Inc. (A Daco Laboratories Ltd. Company) 1131 Erie Street, Box 760 Stratford, Ontario N5A 6W1	Tel (519) 273-4411 1-800-323-9089 Fax (519) 273-4411	email info@stratfordagri.com	Dale Peters Keith Lemp Dr. Jim Brimner

APPENDIX C. Ontario Ministry of the Environment Pesticides Control Offices

Region/County	Pesticides Officer Address	Telephone/Fax
Central Region Toronto, Halton, Peel, York, Durham	**Charles Zubovits** **Cathy Wright** 5775 Yonge Street, 8th Floor Toronto, Ontario M2M 4J1	Tel (416) 326-3671 Tel (416) 326-3477 Toll free 1-800-810-8048 Fax (416) 325-6347
West-Central Region Haldimand-Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	**Charlie Roland** Ontario Government Building 119 King Street West, 12th Floor Hamilton, Ontario L8P 4Y7	Tel (905) 521-7658 Toll free 1-800-668-4557 Fax (905) 521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Peterborough, Victoria, Northumberland, Renfrew, Ottawa-Carleton, Lanark, District of Nipissing (Townships of Airy, Murchison, Dickens, Lyell and Sabine)	**Roberto Sacilotto** **Laurel Grills** 133 Dalton Avenue Kingston, Ontario K7L 4X6	Tel (613) 549-4000, ext 2684 Tel (613) 549-4000, ext. 2702 Toll free 1-800-267-0974 Fax (613) 548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth,Simcoe	**Gary Roberts** 659 Exeter Road, 2nd Floor London, Ontario N6E 1L3	Tel (519) 873-5047 Toll free 1-800-265-7672 Fax (519) 873-5020
Northern Region Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma East, Cochrane East, Haliburton, Muskoka	**John Negusanti** 199 Larch Street, Suite 1101 Sudbury, Ontario P3E 5P9	Tel (705) 564-3249 Toll free 1-800-8890-8516 Fax (705) 564-4180
Kenora, Rainy River, Thunder Bay, Algoma West, Cochrane West	**Don Mitchell** 435 James St. S., Suite 331 Thunder Bay, Ontario P7E 6S7	Tel (807) 475-1712 Fax (807) 475-1745
Standards Development Branch	Pesticides Section 40 St. Clair Avenue West, 7th Floor Toronto, Ontario M4V 1M2	Tel (416) 327-5519 Fax (416) 327-2936
Approvals Branch	Pesticides Licensing 2 St. Clair Avenue West, 12A Floor Toronto, Ontario M4V 1L5	Tel (416) 314-8001 Toll Free 1-800-461-6290 Fax (416) 314-8452

AGRICULTURE & AGRI-FOOD CANADA

Research Centres

Eastern Cereals and Oilseeds Research Centre
960 Carling Avenue
Ottawa, K1A 0C6
Tel (613) 759-1952
Web site http://res2.agr.ca/ecorc/index.htm

Greenhouse and Processing Crops Research Centre
Harrow N0R 1G0
Tel (519) 738-2251
Web site http://res2.agr.ca/harrow/

Southern Crop Protection and Food Research Centre
Web site http://res2.agr.ca/london/pmrc/
1391 Sandford Street
London N5V 4T3
Tel (519) 457-1470

Vineland Research Farm
4902 Victoria Avenue North
Vineland L0R 2E0
Tel (905) 562-4113

Delhi Research Farm
Box 186 Schafer Road
Delhi N4B 2W9
Tel (519) 582-1950

CANADIAN FOOD INSPECTION AGENCY

Web site www.cfia-acia.agr.ca/

Regional Offices (Plant Protection)

Belleville, 345 College Street East
Belleville, K8N 5S7
Tel (613) 969-3333

Brantford, Federal Building, Dalhousie & Queen St., P.O. Box 637
Brantford, N3T 5P9
Tel (519) 751-8157

Hamilton, 709 Main Street West, Suite 101
Hamilton, L8S 1A2
Tel (905) 572-4152

London, 1200 Commissioners Road East, Unit 19
London, N5Z 4R3
Tel (519) 691-1300

Niagara Falls
Mailing address*: R.R. 1, P.O. Box 7, Niagara Falls, L0S 1J0*
Street address: 14154 Niagara River Parkway, Unit 5
Niagara-on-the-Lake
Tel (905) 262-5331

Ottawa District
3 Observatory Crescent
Building #3 Central, Experimental Farm
Ottawa, K1A 0C9
Tel (613) 759-1571

Toronto, 401 Champagne Drive, Unit 1
Downsview, M3J 2C6
Tel (416) 954-1714

Windsor, 441 University Avenue West, Suite 208
Windsor, N9A 5P9
Tel (519) 252-7095

UNIVERSITY OF GUELPH

Main Campus, Guelph, N1G 2W1
Tel (519) 824-4120
Web site www.uoguelph.ca

Alfred College, Alfred, K0B 1A0
Tel (613) 679-2218
Web site www.alfredc.uoguelph.ca

Kemptville College, Kemptville, K0G 1J0
Tel (613) 258-8336
Web site www.kemptvillec.uoguelph.ca

Ridgetown College, Ridgetown, N0P 2C0
Tel (519) 674-1500
Web site www.ridgetownc.on.ca

Department of Plant Agriculture

Web site www.plant.uoguelph.ca

Department of Plant Agriculture, Kettleby
1125 Woodchopper's Lane, R.R. # 1
Kettleby, L0G 1J0
Tel (905) 775-3783

Department of Plant Agriculture, Simcoe
Box 587 Blue Line Road
Simcoe, N3Y 4N5
Tel (519) 426-7127

Department of Plant Agriculture, Vineland
Box 7000, 4890 Victoria Avenue North
Vineland Station, L0R 2E0
Tel (905) 562-4141

Lab Services Division

Web site www.uoguelph.ca/labserv/

Pesticide and Trace Contaminants
P.O. Box 3650, 95 Stone Road West,
Guelph, N1H 8J7
(519) 767-6200

Pest Diagnostic Clinic
(519) 767-6256

AGRICORP (Crop Insurance)

Customer Action Centre
P.O. Box 3660 Station Central, Guelph, N1H 8M4
Tel 1-888-AGRI-999 (1-888-247-4999)
Web site www.agricorp.com

APPENDIX E. Diagnostic Service

Samples for disease diagnosis, insect or weed identification, nematode counts and Verticillium testing can be sent to:

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Road West
Guelph Ontario, N1H 8J7
Tel: (519) 767-6256
Fax: (519) 767-6240
E-mail pdc@lsd.uoguelph.ca
Web site: www.uoguelph.ca/pdc

Payment must accompany samples at the time of submission. Submission forms are available at the clinic's Web site.

Fee Schedule

Procedures	**Price/ Sample**
Plant Diseases	
Diagnosis not requiring plating	$25.00
Diagnosis requiring plating	$40.00
Turf diagnosis	$50.00
Bacterial identification using Biolog®	$95.00
Detection of virus using Transmission Electron Microscopy	$85.00
Detection of virus using ELISA (turnaround time = 5 working days; bulk rates available)	$60.00
Weed identification	$40.00
Insects	
Basic identification	$25.00
Identification requiring dissection and/or extensive keys	$40.00
Nematode and Verticillium Counts	**Price/ Sample**
Nematodes extracted from soil (Bearman Pan Method)	$25.00
SCN cyst count + egg count	$35.00
Nematodes extracted from roots	$60.00
Verticillium count	$60.00

Turnaround time:
Nematodes extraced from soil = 7 to 8 days
Nematodes extracted from roots = 15 days
Cyst counts = 3 to 4 days

Charges will be applied to each sample submitted.
Payment: Please make cheque payable to the University of Guelph. VISA and Mastercard are accepted. Please do not mail cash.

How to Sample for Nematodes

Soil

When to Sample

Soil and root samples can be taken at any time of the year that the soil is not frozen. In Ontario, nematode soil population levels are generally at their highest in May and June and again in Sept. and Oct.

How to Sample Soil

Use a soil sampling tube, trowel or narrow-bladed shovel to take samples. Sample soil to a depth of 20–25 cm (8–10 in.). If the soil is bare, remove the top 2 cm (1 in.) prior to sampling. A sample should consist of 10 or more subsamples combined. Mix well. Then take a sample of 1/2–1 L (1 pint–1 quart) from this. No one sample should represent more than 2.5 ha (6.25 ac). Mix subsamples in a clean pail or plastic bag.

Sampling Pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees, this is the drip line).

Number of Subsamples

Based on the total area sampled:

500 m^2 (5,400 ft^2)	10 subsamples
500 m^2–0.5 ha (5,400 ft^2–1.25 ac)	25 subsamples
0.5 ha–2.5 ha (1.25–6.25 ac)	50 subsamples

Roots

From small plants, sample the entire root system plus adhering soil. For large plants, 10–20 g (1/2–1 oz.) dig fresh weight from the feeder root zone and submit.

Problem Areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take samples from healthy areas in the same field. If possible, take both soil and root samples from problem and healthy areas in the same field.

Sample Handling

Soil Samples

Place in plastic bags as soon as possible after collecting.

Root Samples

Place in plastic bags and cover with moist soil from the sample area.

Storage

Store samples at 5–10°C (40–50°F) and do not expose them to direct sunlight or extreme heat or cold (freezing). **Only living nematodes can be counted. Accurate counts depend on proper handling of samples.**

Submitting Plant for Disease Diagnosis or Identification

Sample Submission Forms

Carefully fill in all of the categories on the form. In the space provided, draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past 3 years and this year's pesticide use records.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. For turfgrass, submit a 10–15 cm^2 piece of turf, including thatch and at least 5 cm of soil. Take the sample from the outside edge of a ring or patch, and include healthy and unhealthy turf, as well as the interface between. If symptoms are general, collect the sample from an area where they are of intermediate severity. **Completely dead material is usually inadequate for diagnosis**.

With plant specimens submitted for identification, include at least a 20–25-cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to avoid drying out and contamination of the leaves by soil. Do **NOT** add moisture, as this encourages decay in transit. Cushion specimens and pack in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

Delivery

Deliver to the Pest Diagnostic Clinic as soon as possible by first class mail or by courier at the beginning of the week.

Submitting Insect Specimens for Identification

Collecting Samples

Place dead, hard-bodied insects and spiders in vials or boxes and cushion with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant "food" to support them during transit. Be sure to write "live" on the outside of the container.

UNIVERSITY of GUELPH **LABORATORY SERVICES**

95 Stone Road West
Guelph, ON N1H 8J7
Tel: (519) 767-6256
Fax: (519) 767-6240
Web: www.uoguelph.ca/pdc

Pest Diagnostic Clinic

SAMPLE SUBMISSION FORM

LABORATORY USE ONLY: **LS Form: SubP01/04/03**

Rec'd: By:____________ **Date Received:** ____________

Delivered By: ☐ **Mail** ☐ **Courier** ☐ **In-Person**

LS Sample No: ____________ **to** ____________

Payment Rec'd: $__________ **Receipt #:**__________

Submitted By:			Owner (if different from submitter):		
Business Name (if applicable):			Business Name (if applicable):		
Street:			Street:		
City:	Prov:	Postal Code:	City:	Prov:	Postal Code:
Tel: ( ) -	Fax: ( ) -		Tel: ( ) -	Fax: ( ) -	
Email:			Email:		

Unless otherwise indicated, report and invoice will be sent to submitter.

Report to: ☐ Submitter ☐ Owner Required Report Format: ☐ Fax ☐ E-Mail ☐ Mail

Invoice to: ☐ Submitter ☐ Owner Quotation #: ________ Purchase Order / U of G G/L code: ____________

Services Required: ☐ Nematode Count ☐ Nematode Count from Roots ☐ SCN Cyst & Egg Count ☐ Verticillium Count ☐ Plant Disease Diagnosis ☐ Insect Identification ☐ Plant Identification ☐ Triazine Resistance Test

Plant or Host Affected:		Cultivar/Variety:	Grower/Field sample #:
		Location of Plant (i.e. greenhouse, field, orchard, garden, etc.):	
Size of Planting:	% of Plants Affected:	Symptoms First Appeared in Past: ☐ Days ☐ Weeks ☐ Months ☐ Years	Degree of Injury: ☐ Severe ☐ Moderate ☐ Light
Cropping History:		Future Crop:	

Describe the problem in detail (i.e. symptoms, plant parts affected, distribution of symptoms):

Were chemicals applied? Please specify type of product(s) used and date(s) of application:

Additional comments and specific requests:

Additional sheet(s) attached: ☐

APPENDIX F. List of Monitoring Equipment and Biological Agent Suppliers

The following is a partial list of suppliers of IPM monitoring equipment, including weather machines, monitoring equipment, and biological control agents.

Note: Inclusion in this list of companies does not imply any endorsement or recommendation by the Ontario Ministry of Agriculture, Food and Rural Affairs.

Company	Contact	Products
Cooper Mill Ltd. R.R. # 3 Madoc, Ontario K0K 2K0	Phone: (613) 473-4847 Fax: (613) 473-5080 Email: ipm@coopermill.com Web site: www.coopermill.com	Pheromone lures and traps
Gempler's 100 Countryside Drive, Belleville, Wisconsin 53508	Phone: 1-800-382-8473 Fax: 1-800-551-1128 Web site: www.gemplers.com	Weather monitoring equipment Pheromone lures and traps Apple maggot spheres Tangle trap Magnifiers Tally counters
Great Lakes IPM 10220 Church Road NE Vestaburg, Michigan 48891	Phone: (989) 268-5693 Fax: (989) 268-5311 Email: glipm@nethawk.com Web site: www.greatlakesipm.com	Apple scab monitoring equipment Pheromone lures and traps Apple maggot spheres Tangle trap Magnifiers Tally counters Insect sweep nets Field diagnostic equipment
Natural Insect Control R.R. # 2 Stevensville, Ontario L0S 1S0	Phone: (905) 382-2904 Fax: (905) 382-4418 Email: nic@niagara.com Web site: www.naturalinsectcontrol.com	Beneficial insects, mites and nematodes Pheromone traps and lures Mating disruption devices Bird houses
Phero Tech 7572 Progress Way Delta, B.C. V4G 1E9	Phone: (604) 940-9944 Fax: (604) 940-9433 Email: sales@pherotech.com Web site: www.pherotech.com	Pheromone lures and traps
Plant Products Co. Ltd. 314 Orenda Rd. East Brampton, Ontario L6T 1G1	Phone: 1-800-387-2449 Fax: (905) 793-9157 Email: sales@plantprod.com	Beneficial insects and mites Magnifiers
N.M. Bartlett Inc. 4509 Bartlett Road Beamsville, ON L0R 1B1	Phone: (905) 563-8261 Fax: (905) 563-9544 Web site: www.bartlett.ca	Pheromone lures and traps
Solida Distributions 480 Rang St-Antoine St. Ferred-Les-Neiges, Quebec G0A 3R0	Phone: (418) 826-0900 Fax: (418) 826-0901 Email: solida@clic.net	
Warwick Orchards and Nursery R.R. # 8 Watford, Ontario N0M 2S0	Phone: (519) 849-6730 Fax: (519) 849-6731	Dewit leaf wetness sensors

APPENDIX G. Crop Insurance

The Canada-Ontario Crop Insurance Program is publicly funded by the Canadian and Ontario governments, and delivered by AGRICORP. The federal and provincial governments each contribute 25% of the premium cost and 50% of the administrative costs. Both these contributions enable an Ontario grower to purchase insurance coverage at a substantially reduced cost.

The grower's payment is considered an operating expense for income tax purposes. Crop insurance offers protection against a broad range of production hazards, including excessive rain, hail, excessive drought, freeze, frost, excessive wind and certain insects and diseases.

For further information, please call AGRICORP's Customer Action Centre at 1-888-AGRI-999 (1-888-247-4999)

AGRICORP
1 Stone Road West
Box 3660, Station Central
Guelph, ON N1H 8M4
519-826-3276
1-888-247-4999
519-826-4118 (fax)
Web site: www.agricorp.com

Ontario Crops Covered by a Crop Insurance Plan

Fruit Crops	Vegetables	General Crops	Tobacco
Apples (fruit and/or trees)	Asparagus	Beans, coloured	Black
Cherries, sweet and sour	Beets (processing)	Beans, white	Flue-cured
Grapes (fruit and/or vines)	Broccoli	Canola	
Peaches	Cabbage	Corn (grain and silage)	
Pears	Carrots (fresh and processing)	Corn, seed	
Plums	Cauliflower	Forage	
Strawberries	Celery	Forage, new seeding	
	Cucumbers (processing)	Honey	
	Green Beans and Wax Beans (processing)	Industrial Hemp	
	Lettuce	Peanuts	
	Lima Beans (processing)	Popping Corn	
	Parsnips	Soybeans	
	Peas (processing)	Spring grain	
	Peppers	Sugar beets	
	Potatoes	Sunflowers	
	Rutabagas	Wheat, red spring	
	Seed Onions	Wheat, winter	
	Set Ontions		
	Spanish Ontions		
	Squash (buttternut, processing)		
	Sweet corn (fresh and processing)		
	Tomatoes (fresh and processing)		

Insurance contracts for all other crops are available from AGRICORP Territory Sales Managers.

APPENDIX H. The Metric System

Metric Units

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1,000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1,000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1,000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-Volume Equivalents (for water)

(1.00 kg) 1,000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1,000 milligrams (mg) = 1 gram (g)
1,000 g = 1 kilogram (kg)
1,000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry–Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

Metric Conversions

5 mL = 1 tsp
15 mL = 1 tbsp
28.5 mL = 1 fl. oz.

Application Rate Conversations

Metric to Imperial (Approximate)

litres per hectare x 0.09 = gallons per acre
litres per hectare x 0.36 = quarts per acre
litres per hectare x 0.71 = pints per acre
millilitres per hectare x 0.015 = fluid ounces per acre
grams per hectare x 0.015 = ounces per acre
kilograms per hectare x 0.89 = pounds per acre
tonnes per hectare x 0.45 = tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23 = litres per hectare (L/ha)
quarts per acre x 2.8 = litres per hectare (L/ha)
pints per acre x 1.4 = litres per hectare (L/ha)
fluid ounces per acre x 70 = millilitres per hectare (mL/ha)
tons per acre x 2.24 = tonnes per hectare (t/ha)
pounds per acre x 1.12 = kilograms per hectare (kg/ha)
ounces per acre x 70 = grams per hectare (g/ha)

Liquid Equivalents

Litres/Hectare		*Approximate Gallons/Acre*
50 L/ha	=	5 gal./acre
100 L/ha	=	10 gal./acre
150 L/ha	=	15 gal./acre
200 L/ha	=	20 gal./acre
250 L/ha	=	25 gal./acre
300 L/ha	=	30 gal./acre

Dry Weight Equivalents

Grams or Kilograms / Hectare		*Ounces or Pounds /Acre*
100 g/ha	=	1½ oz./acre
200 g/ha	=	3 oz./acre
300 g/ha	=	4¼ oz./acre
500 g/ha	=	7 oz./acre
700 g/ha	=	10 oz./acre
1.10 kg/ha	=	1 lb./acre
1.50 kg/ha	=	1¼ lb./acre
2.00 kg/ha	=	1¾ lb./acre
2.50 kg/ha	=	2¼ lb./acre
3.25 kg/ha	=	3 lb./acre
4.00 kg/ha	=	3½ lb./acre
5.00 kg/ha	=	4½ lb./acre
6.00 kg/ha	=	5¼ lb./acre
7.50 kg/ha	=	6¾ lb./acre
9.00 kg/ha	=	8 lb./acre
11.00 kg/ha	=	10 lb./acre
13.00 kg/ha	=	11½ lb./acre
15.0 kg/ha	=	13½ lb./acre

Conversion Tables — Metric to Imperial

Length

1 millimetre (mm) = 0.04 inch
1 centimetre (cm) = 0.40 inch
1 metre (m) = 39.40 inches
1 metre (m) = 3.28 feet
1 metre (m) = 1.09 yards
1 kilometre (km) = 0.62 mile

Area

1 square centimetre (cm^2) = 0.16 square inch
1 square metre (m^2) = 10.77 square feet
1 square metre (m^2) = 1.20 square yards
1 square kilometre (km^2) = 0.39 square mile
1 hectare (ha) = 107,636 square feet
1 hectare (ha) = 2.5 acres

Volume (dry)

1 cubic centimetre (cm^3) = 0.061 cubic inch
1 cubic metre (m^3) = 1.31 cubic yards
1 cubic metre (m^3) = 35.31 cubic feet
1,000 cubic metres (m^3) = 0.81 acre-foot
1 hectolitre (hL) = 2.8 bushels

Volume (liquid)

1 millilitre (mL) = 0.035 fluid ounce
1 litre (L) = 1.76 pints
1 litre (L) = 0.88 quart
1 litre (L) = 0.22 gallon (Imp.)
1 litre (L) = 0.26 gallon (U.S.)

Weight

1 gram (g) = 0.035 ounce
1 kilogram (kg) = 2.21 pounds
1 tonne (t) = 1.10 short tons
1 tonne (t) = 2,205 pounds

Pressure

1 kilopascal (kPa) = 0.15 pounds/in.^{2}

Speed

1 metre per second = 3.28 feet per second
1 metre per second = 2.24 miles per hour
1 kilometre per hour = 0.62 mile per hour

Temperature

°F = (°C X 9/5) + 32

Conversion Tables — Imperial to Metric

Length

1 inch = 2.54 cm
1 foot = 0.30 m
1 yard = 0.91 m
1 mile = 1.61 km

Area

1 square foot = 0.09 m^2
1 square yard = 0.84 m^2
1 acre = 0.40 ha

Volume (dry)

1 cubic yard = 0.76 m^3
1 bushel = 36.37 L

Volume (liquid)

1 fluid ounce (Imp.) = 28.41 mL
1 pint (Imp.) = 0.57 L
1 gallon (Imp.) = 4.55 L
1 gallon (U.S.) = 3.79 L

Weight

1 ounce = 28.35 g
1 pound = 453.6 g
1 ton = 0.91 tonne

Pressure

1 pound per square inch = 6.90 kPa

Temperature

°C = (°F – 32) x 5/9

Handy Metric Conversion Factor
Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

Abbreviations

% = per cent (by weight)
ai = active ingredient
AP = agricultural powder
cm = centimetre
cm^2 = square centimetre
DG = dispersible granular
DP = dispersible powder
E = emulsifiable
e.g. = for example
EC = emulsifiable concentrate
F = flowable
g = gram
Gr = granules, granular
ha = hectare
kg = kilogram
km/h = kilometres per hour
kPa = kilopascal
L = litre
m = metre
m^2 = square metre
mL = millilitre
mm = millimetre
m/s = metres per second
SC = sprayable concentrate
SP = soluble powder
t = tonne
W = wettable (powder)
WDG = water dispersible granular
WP = wettable powder

Spraying Record

Crop or Field No.	*Date*	*Material Used*	*Rate or Amount*	*Weather and Soil Conditions*

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide call the Ministry of the Environment at **1-800-268-6060.**

For pesticide poisonings and pesticide injuries call the Poison Information Centre:

Toronto	1-800-268-9017
Ottawa (Bilingual)	1-800-267-1373
Hearing Assistance (TTY)	1-877-750-2233

PREVENT ACCIDENTS

- **Read the label**. Follow all the precautions the label recommends. Read the First Aid section of the label BEFORE you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use**. Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the 4 basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is not a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

For information, or to obtain copies of this or any other ministry publication please: call 1-888-4-OMAFRA (1-888-466-2372) from within Ontario, (519) 826-3700 from outside the province or OMAFRA's TTY line at (519) 826-7402 for the hearing impaired, email your request to *products@omafra.gov.on.ca*, or visit OMAFRA's Web site at *www.gov.on.ca/omafra*.

A complete list of all OMAFRA products and services, and order forms, are available on the Web site. Orders can be faxed to (519) 826-3633 or mailed to Government Information Centre, OMAFRA, 1 Stone Road West, Guelph, Ontario N1G 4Y2.

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